Popular Radio

OCTOBER 1922

15¢

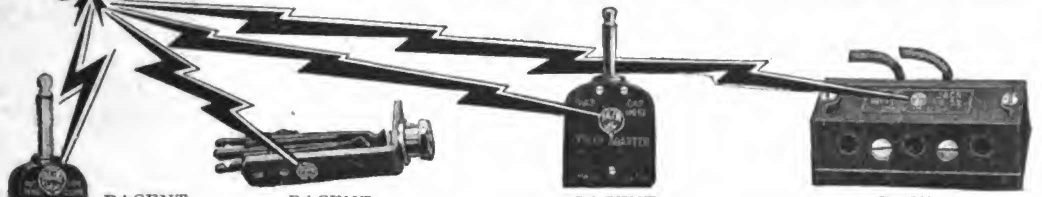
"Radio broadcasting as now conducted may pass. I think that it will. But it will pass into something bigger, into something more useful to men."

George O. Squier

Major General, United States Army

PACENT RADIO ESSENTIALS

PLAY SAFE! LOOK ~ FOR ~ THE PACENT TRADE MARK



PACENT Universal Plug

PACENT Radio Jack

PACENT Twin Adapter

PACENT Multi-Jack

PACENT Audioformer

PACENT Universal Detector Stand

PACENT Duo-lateral Coil

WHY TAKE CHANCES?

THE PACENT TRADEMARK IS A SAFE BUYING GUIDE

It is Your Guarantee of Quality, Satisfaction and Service

In the ordinary purchases which you make every day, you invariably depend upon some mark of quality as an assurance of value and satisfaction. In buying radio materials the average purchaser is a great deal more dependent upon the reputation of the manufacturer than in buying everyday commodities. A radio instrument may look good and act bad. How much more important it is in this case, therefore, to look for the trademark of a competent, dependable manufacturer; The Pacent trademark on any radio product is an absolute assurance of satisfaction.

WHAT THE PACENT TRADEMARK MEANS TO YOU

It means that the device bearing this trademark was made to fill a definite, important radio need: that is the meaning of PACENT RADIO ESSENTIALS.

It means that the product was originated by a radio expert and has passed the acid test of experience. The Pacent Plug was the *first* radio plug; the Pacent Jacks were the first radio jacks, and so with the Twin Adapter, Multijack and other PACENT RADIO ESSENTIALS. Every Pacent product is also backed up with Mr. Pacent's fifteen years' personal experience in the radio industry.

The Pacent trademark means that the product is one of a group generally recognized by radio authorities as leaders in their line. Pacent jacks and plugs are standard with the largest radio manufacturers. Pacent Duo-lateral Coils, besides being used in standard sets of wide distribution, were approved and used by Major Armstrong as important elements in his new super-regenerative circuit, together with other Pacent products. All PACENT RADIO ESSENTIALS are also approved and sold by the leading radio distributors.

Therefore, when you buy PACENT RADIO ESSENTIALS bearing the Pacent trademark you are absolutely sure that you are getting the best for your money. You are playing *safe*. Don't accept substitutes, imitations or something "just as good." Insist on seeing the Pacent trademark.

DON'T IMPROVISE—PACENTIZE

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Member Radio Section, Associated Manufacturers of Electrical Supplies

POPULAR RADIO

EDITED *by* KENDALL BANNING

CONTENTS *for* OCTOBER, 1922

(Cover design by Joseph Cummings Chase)

VOLUME II — NUMBER 2

DEPARTMENTS

VOLUME II — OCTOBER, 1922 — NUMBER 2

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E. E. FREE, Ph.D., *Contributing Editor* LAURENCE M. COCKADAY, R.E., *Technical Editor*


GREBE RADIO
"TREASURES OF GOLD AND JADE' SAID LAO TZU, 'DESERVE A PROPER DWELLING!'
"GREBE RADIO IS NOW HOUSED IN A MANNER BEFITTING ITS EXCELLENCE."
Doctor Wu
H.A. WEISS

A PAGE WITH THE EDITOR

IF our readers could only peep over the Editor's shoulder at the store of timely and interesting articles that are scheduled for publication during the next few months they would become as impatient over the delay in getting them into our magazine as is the Editor himself. Our editorial files are rapidly becoming a veritable gold mine of material—articles of practical helpfulness to the radio fan everywhere. Among our contributors whose manuscripts are awaiting the chance to appear in our pages are such distinguished men as Dr. Lee De Forest, Commander S. C. Hooper, John V. L. Hogan, Thomas C. Martin, Guglielmo Marconi, Sir Oliver Lodge, Hiram Percy Maxim, Prof. William C. Ballard, Jr., Prof. J. H. Morecroft, Waldemar Kæmpffert, Dr. Clayton H. Sharp, Prof. Gordon D. Robinson, Dr. Henry Smith Williams—to mention only a few. Only the limitations of space at present available prevent the early publication of *all* this material. The question is whether or not the Editor is not in duty bound (entirely aside from the extra expense involved) to enlarge POPULAR RADIO and thus enable our readers to profit from this material while it can be of the greatest timely value to them. Some of our readers have been urging the Editor to do just this.

What do *you* think?

* * *

THE feat of broadcasting the concerts of the New York Philharmonic orchestra served as a two-edged sword; it hit both the radio fan and the music lover. No more flattering tribute to the part played by POPULAR RADIO in this undertaking has been paid than that written by the indefatigable Cromwell Childe, of the Philharmonic orchestra management:

"Music has had signal service done for it," he gracefully acknowledges, "and in a way that seems incredible. The night of August 11th, 1922, is memorable in the annals of music. . . . But the real historic moment came several weeks before that date; a record of it should be preserved. On the field of the Stadium one evening in July the Editor of POPULAR RADIO met the manager of the concerts, Arthur Judson, and the writer. 'Why not broadcast these concerts?' the editor asked. Mr. Judson and I looked at each other. 'Yes,' we agreed. And so it all began."

* * *

No more impressive demonstration can be required, even by the most exacting editor, of the eagerness with which his subscribers look forward to the arrival of the magazine each month than the disappointment they experience when something deprives them of their accustomed treat. When Fred C. Clough, of Ridgefield, New Jersey, found that he had received a spoiled copy he sent a messenger all the way to our office in New York to replace it with a perfect copy. And as for old Major Lawrence Mott, known to amateurs throughout the country as 6XAD (and an editor of an Esteemed Contemporary), his perfectly justified chagrin over a similar experience overcame him completely and stirred him to send a telegram from Avalon, California—clear across the continent—for a duplicate copy!

The Editor is grateful for this proof of esteem. If he were a subscriber he would do exactly what these two subscribers did!

* * *

"BUT won't the radio craze pass?" now asks the inevitable sceptic. He asked the same question years ago about the steam engine, the talking machine and the motion picture: his clinching argument against the automobile was that it could not possibly come into general use "because it would scare all the horses!"

No, radio will not pass—at least not until electricity becomes a quaint and useless toy. Indeed, it is not unlikely that radio will prove to be the most significant discovery yet made by man. Certainly no development of science has so stirred the imagination or promised such far-reaching effects upon civilization.

* * *

HERE'S a man after our own heart! George A. Martin is so properly fearful lest he miss a single issue of POPULAR RADIO that he sent in his subscription from Buffalo by special delivery!

* * *

"I MUST admit that POPULAR RADIO," writes Thomas Hedges from Oklahoma, "is about the only radio magazine that I can really understand."

"After a week of futile tinkering with my regenerative set," writes Francis Greene of Rensselaerville, N. Y., "I bought a copy of POPULAR RADIO. In it I found in a few moments the solution of my problem in hooking it up. I shifted the connections of my 'B' battery, and ever since I have gotten wonderful results."

These two comments are quoted not because they are exceptional, but because they are representative of the flood of letters that pour into the editorial sanctum. Such messages are particularly gratifying because they indicate that POPULAR RADIO is accomplishing two of its main objects:

First—to present its articles in language so clear that even the radio novice can understand it.

Second—to publish only sound and authoritative information about radio—information that is of practical value and that can be depended upon.

If you see it in POPULAR RADIO, *it's so!*

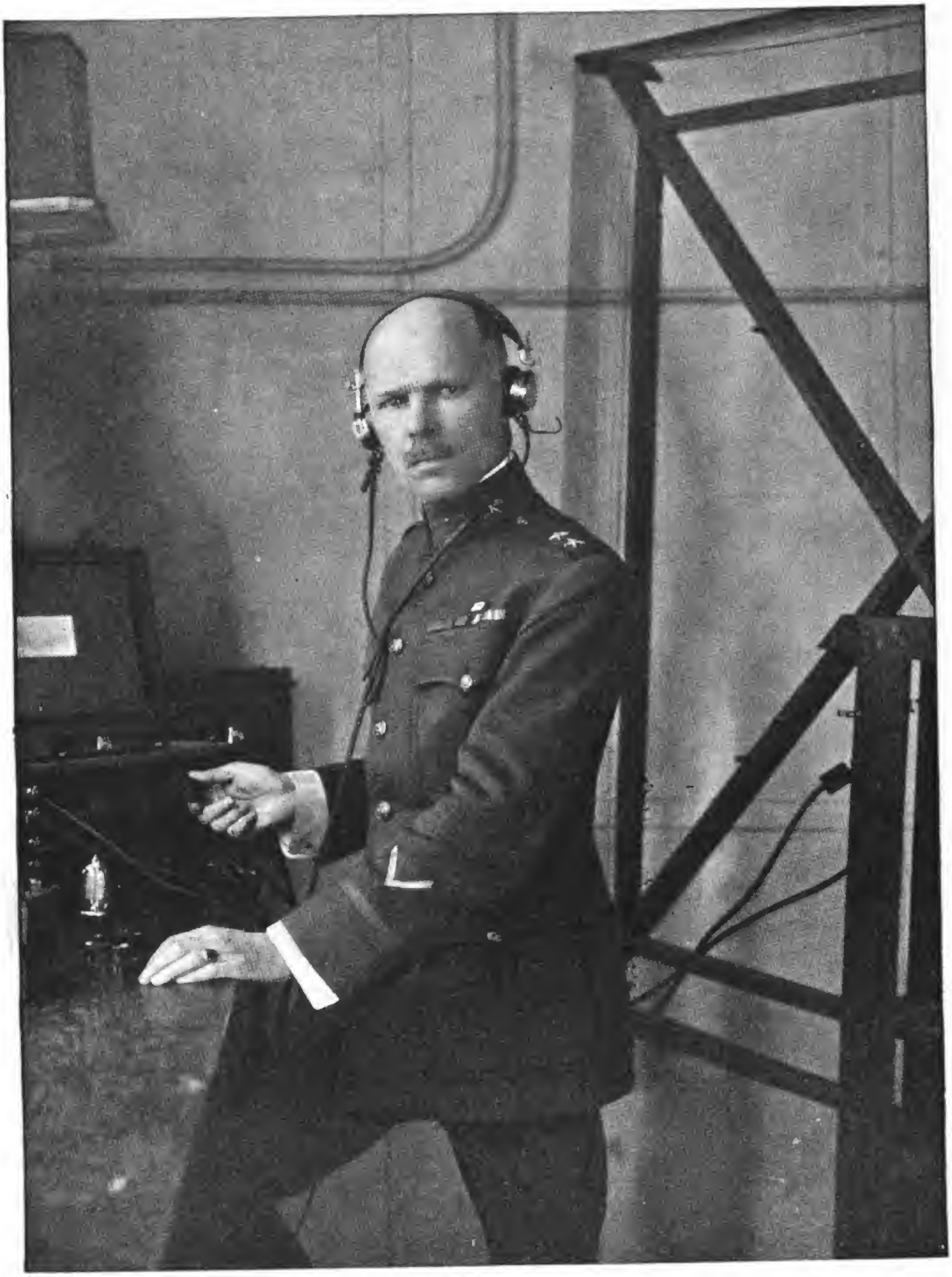
Kendall Banning

Editor, POPULAR RADIO

DR. LEE DE FOREST BROADCASTS HIS OPINION OF *POPULAR RADIO*

It comes very close to my idea of what a popular, semi-technical radio magazine should be.

Lee de Forest.



U. S. Signal Corps

"RADIO will bring to the people of this country the intellectual background which heretofore only the rich could afford. Yet the work of the radio engineer as an educator has only just begun. Soon we will be measuring culture by watts."

—GEORGE O. SQUIER

Popular Radio

VOLUME II OCTOBER, 1922 NUMBER 2

What Will Take *the* Place *of* TODAY'S BROADCASTING?

One of the Possible Solutions of the Most Vital Problem Before the Radio Fan Today, as Proposed by——

MAJOR-GENERAL GEORGE O. SQUIER

BROADCASTING was impossible without an audience. As soon as an audience was provided, broadcasting was possible, and it began. The audience was provided by the boy amateurs—by the youthful tinkerers who for four or five years had been playing with coils and sparks and antennæ—who had been trying, night after night, to get through a few dots and dashes to the other boy enthusiast in the next block. This amateur audience was ready and waiting for the broadcaster; its existence is what made broadcasting such an instantaneous success.

The present conditions in radio are training a larger audience. Father and mother have joined the boys around the radio set. It has been estimated that about five million people listen in every evening on the broadcast programs.

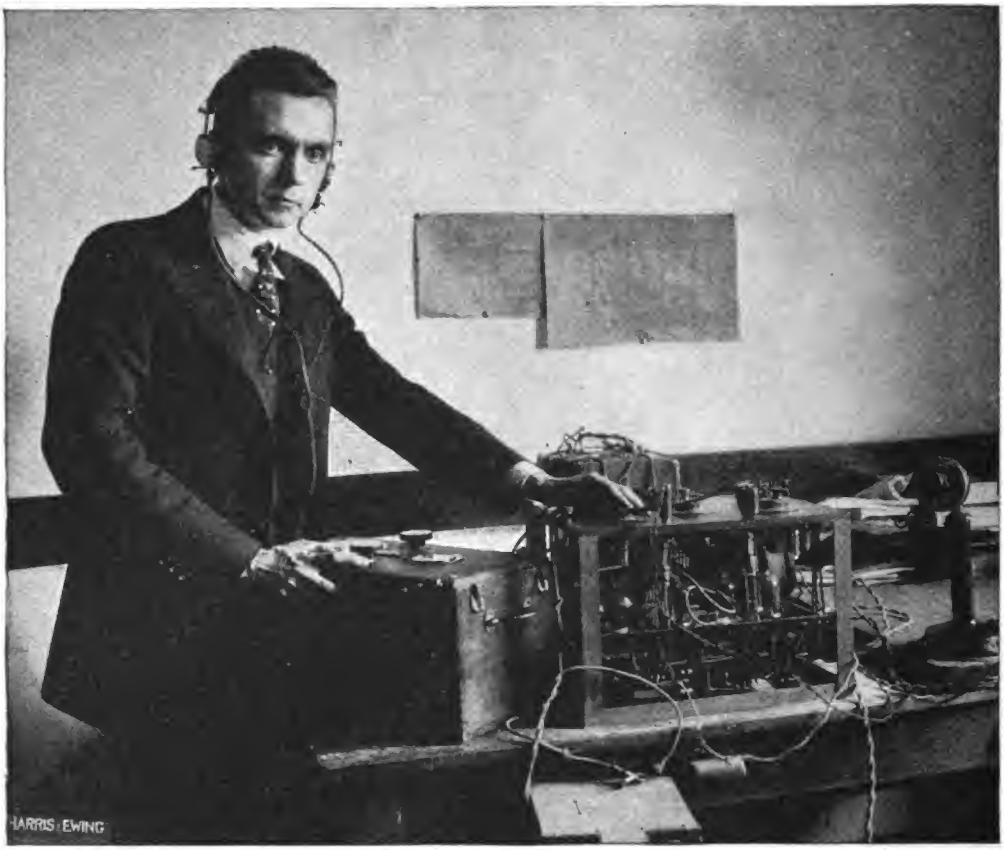
What are we going to do with this audience?

Amateur radio prepared the audience for broadcasting. Broadcasting is now preparing another audience, a larger one —for what?

Some people seem to think that broadcasting is a fad; they believe that people will return for entertainment to the phonograph, to the motion picture and to the spoken drama. They believe, so they say, that the radiophone is a temporary craze.

I do not think so. What happened to amateur radio? In one sense it passed, but it passed into a far bigger thing. It passed into radio broadcasting. Radio broadcasting as now conducted may pass in its turn. I imagine that it will. But it will pass into something else, into something bigger and better, something more useful to men and to society.

The basis of a democracy is education. Unless we can properly educate our children and our immigrants, the American idea of government will fail. And no one can be educated solely in school. Far more important is the atmosphere at home; the background, good, bad or in-



Harris & Ewing

A RADIO RECEIVER THAT USES A TELEPHONE WIRE AS AN AERIAL

The scheme for transmitting radio programs to subscribers only is brought within the realms of possibility by this super-phone, or "line radio duplex transmitter and receiver," developed by R. D. Duncan, Jr., head of the research laboratory of the Signal Corps. The device may be attached to the ordinary desk telephone.

different, against which the family life goes on. Is this a background of good books, good music, intelligent conversation? Or is it a background of crime news from the papers and of neighborhood gossip?

Think of what radio can do to help this situation. Radio can go a long way toward supplying whatever kind of home background the country needs its citizens to have. Inspiring music, the uplifting words of great teachers, the everlasting principles of our political fathers, can be poured every day and hour into the waiting ears of all our citizens—poured in to form the minds of children, to revive the courage of the common man, to instruct and set right the newcomer from foreign lands.

The country can *make* us listen, all of us. It will be so easy to listen that we cannot escape. We will not want to escape. Comfortably, each one of us beside his own library table, in his favorite chair, without cost or exertion or the annoyance of dressing up, there will come to our ears at the turn of a little knob the best thought and the finest artistry of all the world.

And to our children's ears no less. To our children radio will bring the intellectual background which only the very rich have been able to provide, a background of exquisite sound. The poorest

nursery can have its interior decoration of music, its aural furnishing, as now we put bright pictures on its walls. For nurseries and for all the house we can replace mere noise with controlled harmony. Already the music of the Marine Band, which all of us help to support, is not confined to Washington; it is broadcast regularly. Already any little town in Maryland or Virginia can have its radio set and its loud-speakers—can gather in the evening at the band stand for its own concert by this world-famous organization. Yet this is only a beginning of the work of the radio engineer as an educator. Soon we will be measuring culture by watts.

And as to the more permanent social influences of such daily aural backgrounds, what might be, for instance, the influence on business morality if fifty people heard each day the simple and persuasive eloquence of the Sermon on the Mount?

This is exactly what radio can do. The radio engineer will be, I firmly believe, the prophet and the architect of a new social era, the inventor of the first successful system for the education of all the people.

For this to come about we need only two things:

First: we must simplify the radio receiver, and

Second: we must avoid, somehow, the present confusion of broadcast messages, the overcrowding of the ether.

Both of these improvements can be made, and can be made easily.

The Bureau of Standards has produced a vacuum tube equipment which works on an ordinary electric lighting circuit. This may eliminate from the radio set the present type of battery. The principle of the resonance coil, developed in the laboratories of the U. S. Signal Corps, not only accomplishes the virtual elimination of static but reduces the laborious and uncertain tuning to a single operation, to the mere sliding of a contact arm along a coil. These two advances remove the main reasons why the present-day radio set is overcomplicated and is too hard to manage and adjust. The next step is get rid of the aerial. This can be done easily by using the electric light wire or the telephone wire.

Every house has two avenues through which the outside world comes into it, the electric light wire and the telephone wire. Already the massed network of these wiring systems is prodigious in extent. The United States is one vast grid of wire. If some jinn could dissolve away all the brick and iron and concrete of the buildings of lower New York, leaving only the electric light wires, the form of the buildings would be as visible as before. Each floor, each wall, each room would be represented by a cage of intercrossing wires. The telephone wires make another system equally complete and complex, in fact, since the telephone system is continually changing its configuration as its calls are plugged in and out.

Each of these vast networks of wire is really a cage aerial, a three-dimension antennæ system. The electric light wires and the telephone wires of New York pulsate every instant with all the potential changes due to every wireless message passing through the ether. Each Marconigram from Europe is recorded, pulse by pulse, on these two independent networks of wire.

Both of these networks come into your house. Why not use them to get your radio signals? What is the use of spoiling your roof with troublesome and unsightly aerials, or filling up your parlor with complicated loops? The light and telephone wires are there. They have been laboriously and skilfully insulated from the ground and protected against lightning. Why do this all over again for a little private wire system of your own? Why not forget about your own private aerial and use those already available to you?

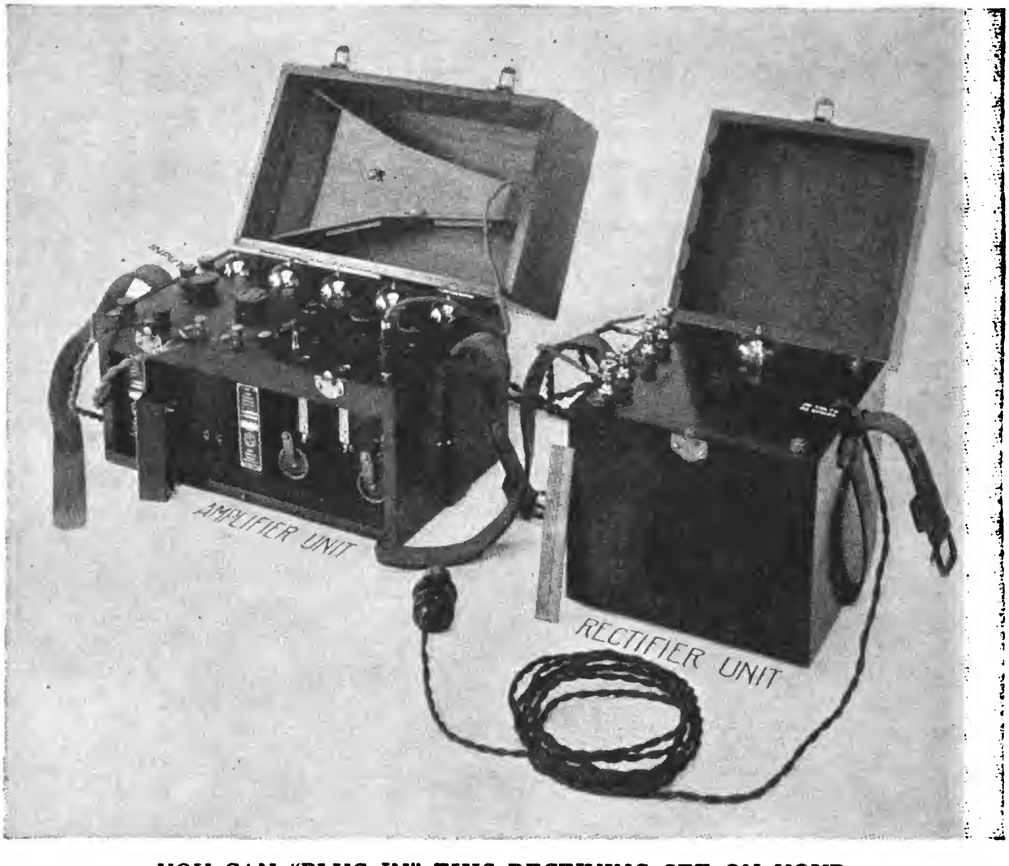
With proper apparatus there is no danger to or from the wires, no interference with their use for light or telephone

service. All the music and speech which is pulsating through the ether, all this wonderful potential background of education, comes into your house anyway through the two avenues, namely, the light wires and the telephone wires. The radio set of the future—I believe, of the very near future—will be some simple apparatus which you can plug into any light socket, or connect to any telephone. It will be something which you can buy in any drug store. It will be something dependable and standard, which you do not have to "set up" or "install."

When we get this we can begin to count on developing an intelligent, well-meaning and broadminded public opinion.

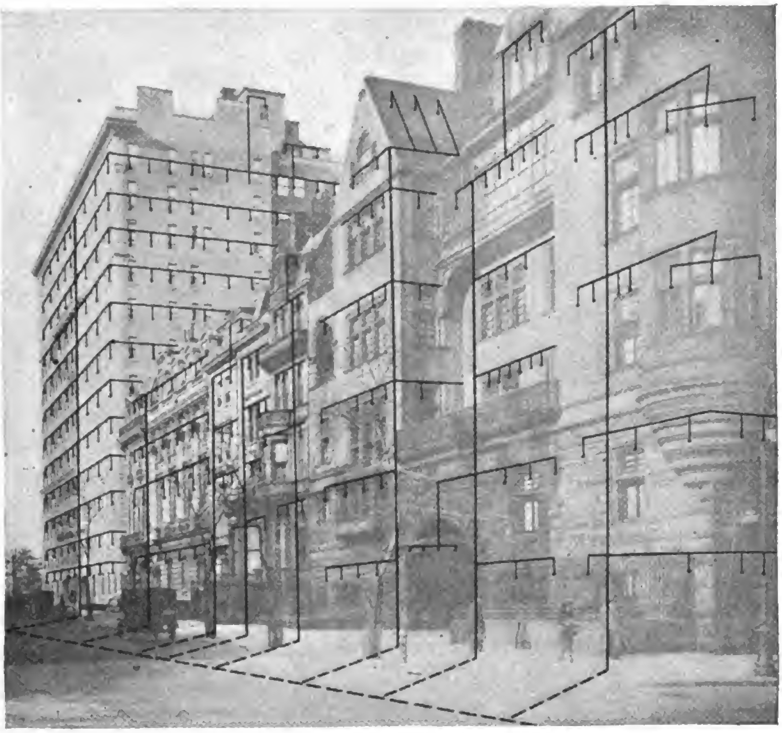
The difficulty of an overcrowded ether can be met with equal ease. The work of the Signal Corps on carrier current radio, or "wired wireless," is well known. By this system radio waves can be sent over ordinary wires. This is already in use for telephone service over power or telegraph wires and for superposing two or more telephone conversations on the same wire.

By the use of this system anything could be broadcast over the electric light wires of a city. Items of local interest only need not be loaded on the ether for everybody to hear; the local



YOU CAN "PLUG IN" THIS RECEIVING SET ON YOUR ELECTRIC LIGHT CIRCUIT

That the ordinary electric light wiring can serve as aerials for "wired wireless" reception has been demonstrated by this receiving set devised by the Bureau of Standards under General Squier's direction. It is possible that the electric light corporations of the future will furnish the broadcast service—to customers only.



From a drawing made for POPULAR RADIO

THE WIRE SKELETON OF A CITY BLOCK

The possibilities of bringing radio programs into buildings by way of the telephone and light circuits is illustrated by this diagram. If all the brick and iron of our city structures were dissolved away, the forms of the buildings would still be indicated by the wiring.

wire systems will carry the load instead.

For instance, department store advertising is of real interest to people who live near the store. It is not of interest to listeners a thousand miles away. It will be necessary to distinguish between local news and general news; between local civic matters and general governmental ones. The use of the local wire systems for broadcasting by radio permits one to make this distinction effective.

Like the use of the electric light wires as aerials, this broadcasting over them will interfere in no way with their proper purpose of carrying current. Several power companies are understood to be experimenting already with the idea of furnishing their customers with broadcast entertainment just as they now furnish them with electric light.

These, then, are the three developments in radio which I can see near at hand.

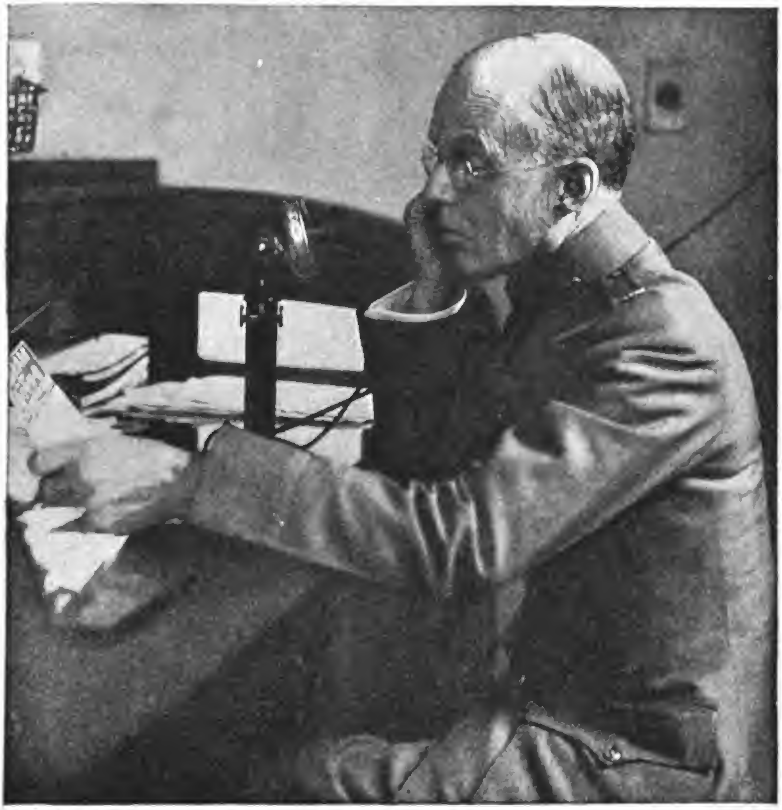
First: the simplification and standardization of the receiving set.

Second: the use of light wires and the telephone wires as aerials for everybody.

Third: the use of local power systems for local broadcasting.

Through these three developments there will come to every man's home a stream of the best things of the world—a stream to be tapped and enjoyed when he wishes, to be shut off by the simple turn of a switch when he does not; a stream out of which he may select what pleases his fancy or meets his changing needs.

Thus will the radio engineer provide a new cultural background for humanity, a new and powerful agency for the advancement of mankind.



Pacific & Atlantic

HE ADMINISTERS TO HIS PATIENTS AT SEA FROM A CITY SKY-SCRAPER

Emergency radio calls for medical help from vessels off our coasts are relayed by Uncle Sam's coastal stations to one of three hospitals maintained by the Bureau of Health—the U. S. Marine Hospital in New York, the U. S. Veterans' Hospital in Philadelphia and the U. S. Marine Hospital in San Francisco—from which expert advice is returned. Dr. E. K. Sprague (shown above) is in command of the New York headquarters of this unique service.

"Old Doctor KDKF"

A Remarkable Form of Long-Range Medical Service that Uncle Sam Is Developing to Cure the Sick and Injured on Ships Beyond the Reach of Surgeons

By HOMER CROY

BLOSSOM HEATH, an English cargo ship, stopped at New York, discharged part of its freight and steamed confidently for Panama. It passed through the Canal and started on the long stretch across the Pacific ocean for Hong Kong and the China Coast.

And then one night, abruptly, misfortune laid its heavy hand on the ship.

There was groaning in the quarters of one of the ship's crew. When help came the cook was writhing in pain. For anything to happen to the chief cook on such a long voyage is a catastrophe. The captain was called and in the glory hole, gently rocking to the movement of

the ship as it plowed steadily into the tropical night, the captain sought to find out what was the matter. But he was not a man of medicine and the cook could tell him little. All the cook knew was that he was in great misery; he had eaten nothing; taken no wrong medicine. He could not explain it. The captain took his pulse, and found a fever thermometer, but otherwise he was helpless. The pains grew worse. It would be days before port was made, before there could be hope of medical attendance.

And then as he bent over the groaning man in his bunk, with the silent seamen outside in the narrow passageway, an idea came to the captain.

"Send me Sparks," he said. Everyone knew what he meant, for over the seven seas the ship's wireless operator is thus known.

The captain wrote a brief description of the cook's symptoms on a pad and signed it as master of the *Blossom Heath*.

"Call Station KPH, San Francisco, and ask them to tell me what to do."

San Francisco answered the call and a physician of the United States Marine Hospital was brought to the telephone. The captain's message was read to him and the doctor gave his advice—and in just sixteen minutes after the captain's message was sent into the air the doctor's advice was back.

Two days later the cook was well!

Thus had the cook on an English cargo ship in the midst of the Pacific ocean been saved by American radio.

Another instance: the *Chester Valley*, one of the United States Shipping Board ships, was at sea when one of the petty officers began to complain of pains. Small sympathy is to be found among the hardened men of the sea until it becomes serious—and then before they realize it, it is too late. It is a stern school. The man's pains grew worse; the captain was sent for and in bewilderment stood over the moaning man. The captain called New York by wireless. Almost immediately advice was back. The man was saved and another feather was added to radio's cap.

On still another occasion, a sailor on a slow-moving cargo ship came down with pneumonia. To cure such a disease was quite beyond the ambitions of even the most adventurous members of the crew. It would be days before the freighter would make land—and the man must have immediate attention. At last a passenger ship was called and its doctor was asked to prescribe. This he did. The two ships were going in the same direction; the passenger ship arrived first and when the freighter came in the doctor, whose interest had been aroused, was there to receive his patient. The sailor was transferred safely to a hospital and in time recovered. Without radio a shorter—and sadder—story would have been written.

Thus do we see the workings of another of the wonders of radio—the giving of medical advice to ships at sea. Sailors now can have the best of medical advice, even though the doctor may be thousands of miles away. Many and many is the ship that has no doctor: freighters, cargo ships, tramp steamers, tankers, fruit boats, fishing vessels, schooners. In fact, only 25 percent of the ships that sail the seas carry doctors. There is a law which requires all ships with fifty or more in the crew to carry a radio outfit, but they may have a hundred in the crew and not have a doctor aboard—so long as they don't carry passengers. But a ship with even one paying passenger must have a doctor. It is one of the queer quirks of the law. To judge by the statutes a seaman is a hale and hearty individual who has felt well ever since he cut his teeth, while a passenger with nothing to do but sit around and enjoy himself is trembling on the brink of a breakdown. As a result, a freighter with a huge crew will start to sea with nothing more complicated in the way of medical nostrums than Nujol and be expected to put into port with every man jack aboard danc-

ing a hornpipe. But if one lone passenger gets aboard, a ship's doctor has to come trailing after him.

The English marine law is better than ours. By it the master of a vessel is required to know the principles of first aid. But we have no such law. The captain of an American freighter can put to sea without knowing a hypodermic needle from a belaying pin. The English captain, in time of emergency, can administer rough help, but our captain can only look sympathetic and offer to write to relatives. As a result, thousands of American seamen suffer. And the stories they can tell! Boxes fall on them, legs are crushed, fingers disappear in the machinery—and the captain is called on to perform the office of doctor. Sailors hold the screaming man while the captain amputates. There is no opiate; the victim is tied to the bunk and the ship goes on. Engine-room waste is used to bind wounds and oakum is poured on open sores. When there is a burn, lubricating oil is emptied on it and the crisis is considered past.

So it has been for many centuries.

From a photograph made for POPULAR RADIO

ACCIDENTS ON DOCTORLESS SHIPS HAVE BROUGHT HORRORS THAT RADIO IS AT LAST RELIEVING

For time immemorial, the only treatment received by injured seamen has been rendered by the ships' captains. Now the emergency ambulance call "KDKF" is bringing expert help even to the remote lanes of the Atlantic and Pacific.

From a photograph made for POPULAR RADIO

THE SHIP MEDICINE CHEST THAT HAS BEEN STANDARDIZED BY "DOCTOR KDKF"

Every vessel may some day be equipped with such a first-aid cabinet that will enable the ship's captain to administer the exact drugs prescribed by doctors via radio.

Then, one day, a man on the top floor of a sky-scraper at 25 South Street, New York, had an idea.

That man is Captain Robert W. Huntington, who has sailed the seas when sailing was sailing and scurvy was a dreaded disease. Once he went out to meet the whale and stood with his finger on the trigger of the harpoon-gun; now he is in the quieter waters of New York Harbor, but his heart is still with the sailors setting their course by the evening star.

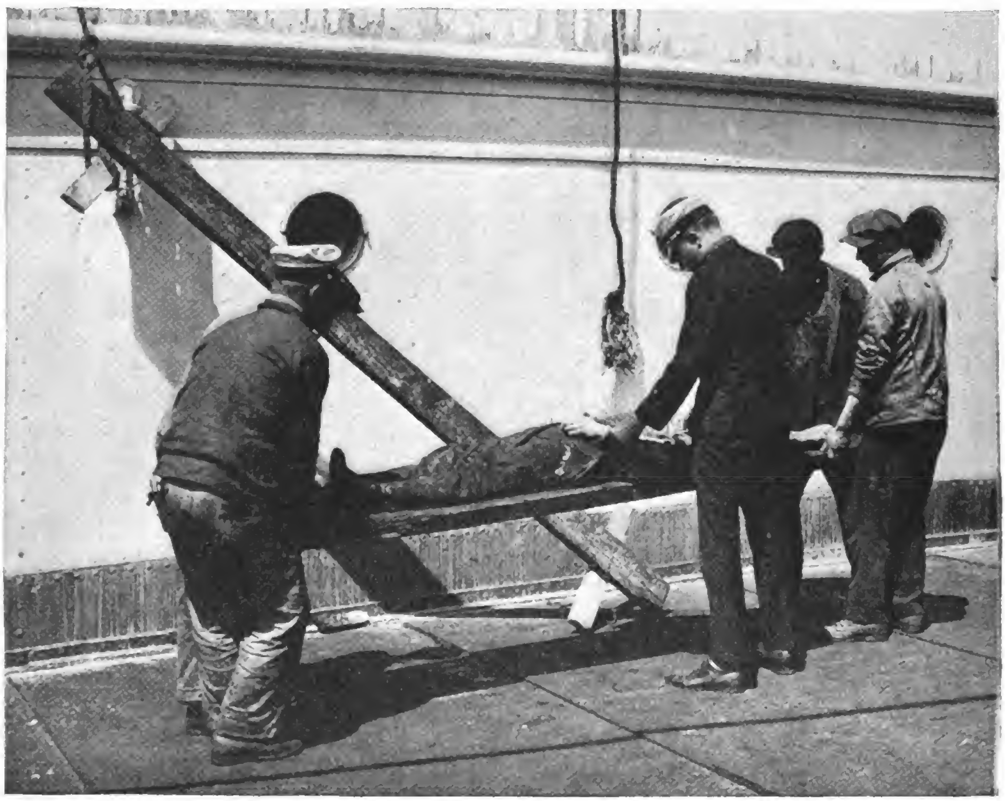
"Why can't we give them medical advice by radio?" he asked.

It was a new idea; it had never been tried. He was connected with the Seamen's Church Institute as chief of the navigation school. Immediately his idea was put up to the authorities. There was a medical staff with the Institute giving advice to sailors ashore; now its services could be enlarged. Washington was communicated with and soon the only doctor thousands of sailors knew was KDKF. When pains set upon them, or when their hands went into the machinery, instead of trusting themselves to the efforts of a bewildered skipper they called the mysterious Dr. KDKF and after a short interval advice came back. That was all they knew. The machine would sputter, sparks would fly and from some place out of the air advice would come.

But this was what was really happening. As soon as the distress message was received an Institute doctor was communicated with. The message was read to him. He in turn telephoned advice back, but the Captain wasn't going to run any risk; passing through so many hands the advice might be garbled. So to the telephone he hitched a dictating

machine, and the doctor's instructions went on wax. These in turn were read back to the doctor and later the record was put away for safe keeping. With the rubber tips in his ears the captain read out to the wireless operator the exact words of the doctor and into the air they were sent flying. The radio operator aboard some lonely ship copied them down and the message was given to the captain. Then, confident of his medical bearing, the ship captain went to the sailor and gave orders with as much assurance as if he had a medical degree. The message, to reach its destination, had gone through four machines—the telephone at the hospital, the wax record, the sending outfit and the receiving outfit on the ship.

So far so good; a great boon had come to the sailorman—or so it seemed. But not as much oil had been poured on the troubled waters as the quieted waves might seem to indicate. Underneath, there was still something wrong. For many times when calls came in for help, and medical advice was sent back, the ship had none of the remedies suggested; in fact, outside of castor oil, calomel and quinine the ship's medical chest was as bare as Mother Hubbard's cupboard. The doctor might prescribe relief, but he had no means of knowing that the ship had this on board. He was prescribing in the dark. Then it was that Captain Huntington hit upon another idea—the idea of the standardized medicine chest.



From a photograph made for POPULAR RADIO

FIRST AID IS NOW RENDERED *VIA* WIRELESS

Not only can the nature of accidents be reported to distant surgeons, but even the patient's heart-beats may be transmitted to him for determining the physical condition. Many a broken bone has been set by instructions received by radio.

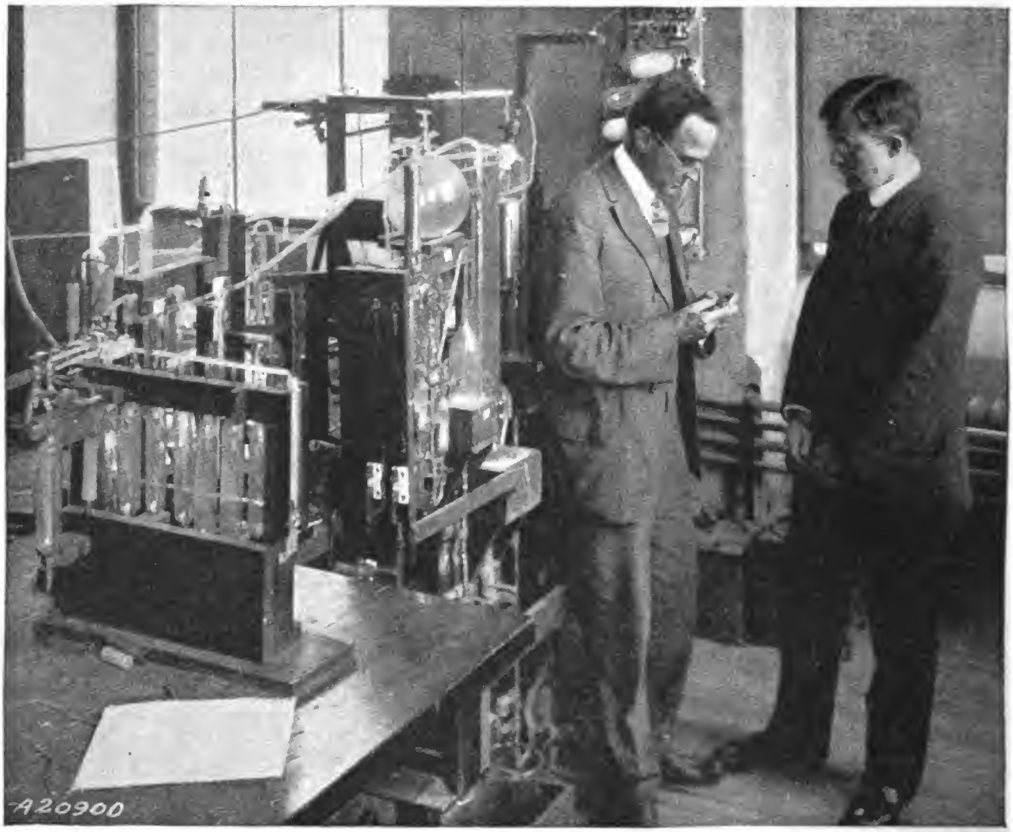
Each ship going to sea was to be equipped with a medicine chest in which were to be all the standard drugs and remedies. These were to be plainly marked; the doctor was to know exactly what was aboard the ship and then he could dovetail complaint and treatment. The matter was taken up with the Department of Commerce and was favorably received. It is now awaiting action. If passed it will bring relief to thousands of seamen who in the past, in the words of the fo'c's'le, have had to grin and bear it. The supplies are to be bought by the United States Public Health Service, that cheap and inferior drugs are not foisted upon the seamen, and inspected from time to time to see that their strength has not deteriorated.

The work of the Seamen's Church Institute continued, and legs were saved and stomachs were calmed, but the job became too big. It meant that an operator must be on duty day and night. Money was low; a few donations came in, but it was more than the Institute could manage on its slender resources. At last arrangements were consummated with the Radio Corporation of America and this in turn with the United States Public Health Service. The doctors of the latter are at its call. It now has stations at Chatham, Mass,; Siasconset, Mass.; on the Bush Terminal Building, Brooklyn; one in Cape May, New Jersey, and another in San Francisco. The call letters, in order, are: WCC, WSC, WNY, WCY, with KPH for San Francisco.

Thousands and thousands of sailors—who once suffered and died needlessly—now, in whatever part of the world they are, can have medical aid within a few minutes. In fact, it is now possible for a sailor in the Sargasso Sea to get attention more quickly than if the doctor lived a few blocks up the street. With radio there is always a doctor at home. Radio has hung a shingle on every ship.

"SPARKS"

The law requires every ship that carries a crew of fifty or more to carry along a radio outfit also. The radio operator is known aboard as "Sparks."



General Electric

A SCIENTIST WHO CONTRIBUTES TO THE WORLD AN ALMOST-PERFECT NOTHING

Dr. Irving Langmuir (at right), inventor of the Langmuir pump that has removed about 99.999,999,990 percent of air from a tube, and who has thus made possible the high vacuum tubes used in radio. He is conferring with Dr. W. R. Whitney.

The Bottle Filled With .000,000

The Key to the Radio Art Is the Vacuum Tube; the Secret of the Vacuum Tube Is the Vacuum Created Inside of It. This Article Reveals How this Vacuum Is Made

By E. E. FREE, Ph.D.

MODERN radio depends upon our ability to fill a bottle with nothing. The bottle is the vacuum tube. The nothing is the vacuum.

To the layman this seems perfectly simple. You merely take a glass bulb and pump the air out of it. Inside you have a vacuum.

The physicist knows that this is easier to say than to do. For hundreds of years science has been trying to learn how to pump all of the air out of anything. So far science has failed. No one has ever gotten out every last molecule and atom of air and of every other gas. No one has produced an absolutely per-

fect vacuum. Probably no one ever will.

Nature not only abhors a vacuum, but she takes mighty good care that nobody ever gets one.

But science has come very close to a perfect vacuum. After many years of research, after the laborious study and improvement and final rejection of scores of different methods of producing a vacuum, science has come at last close enough to perfection for the practical problem of producing a workable electron tube for radio use. This was done, as it happens, not for radio purposes at all, but in connection with some fundamental scientific researches on the theory of the ordinary incandescent lamp and on the X-ray tube; one more example of the way in which scientific researches undertaken for one object or for no object at all except the pursuit of knowledge, turn out so often to be useful in directions originally quite unforeseen.

This is the story of the present state of this long search for the perfect vacuum, of why high vacua are necessary in radio tubes, of how they are produced, of why a perfect vacuum is so exceedingly hard to get, of how air molecules penetrate into solid glass and then boil out of it as they might out of water, of how this and other experimental difficulties have been fought and overcome. Were it not for the success of the scientists in these researches (partial success though it is) the radiophone as we know it could not exist. You can receive with a crystal but you cannot send with a crystal. Modern radio depends absolutely on the vacuum tube, on some or all of its many uses. And the vacuum tube is possible only by virtue of what science has discovered about vacua and how to get them.

The most perfect vacuum attained so far by any scientist is one in which the remaining gas—the tiny fraction by which the vacuum fails of being perfect—has a pressure of about .000,000,075 millimeters of mercury. The ordinary air pressure is about 760 millimeter of mercury. In this almost perfect vacuum, therefore, about 99.999,999,990 percent of the air has been removed. Less than one ten-billionth of the air originally present has been left.

Scientists and engineers have three common ways of denoting gas pressures. One is the equivalent mercury column, as in the ordinary barometer, and as used above. Another is in pounds per square inch. A third is in "atmospheres," one atmosphere being the normal pressure of the air at sea-level. An atmosphere equals approximately 760 millimeter of mercury, or 14.5 pounds per square inch.

The record vacuum noted, the vacuum of .000,000,075 mm. of mercury, equals approximately .000,000,001,4 pound per square inch, or a little less than one ten-billionth of one atmosphere.

Though this is the measured record it is possible that vacua slightly more perfect than this have been attained in some of the experiments. The measurement of these very low air-pressures is extremely difficult. Ordinary barometers and gauges are useless, and the very delicate instruments which have to be used are not perfectly dependable. It is suspected that they may not have recorded perfectly the lowest pressures—the highest vacua—attained.

But, at the least, a vacuum of about one ten-billionth atmosphere has certainly been reached; it has been reached, indeed, many times. Yet even this extreme attenuation of the air is still far from a perfect vacuum. The evacuated bulb is not really empty. An ordinary vacuum tube for radio use has a volume of at least two ounces, about 50 cubic centimeters. At the highest attained vacuum of one ten-billionth atmosphere a tube like this will still have inside it about one hundred and thirty billion molecules of air—more than eighty times as many molecules as there are people living in the world.

And this tube, with its one hundred and thirty billion gas molecules still inside it, is the emptiest space that anybody has

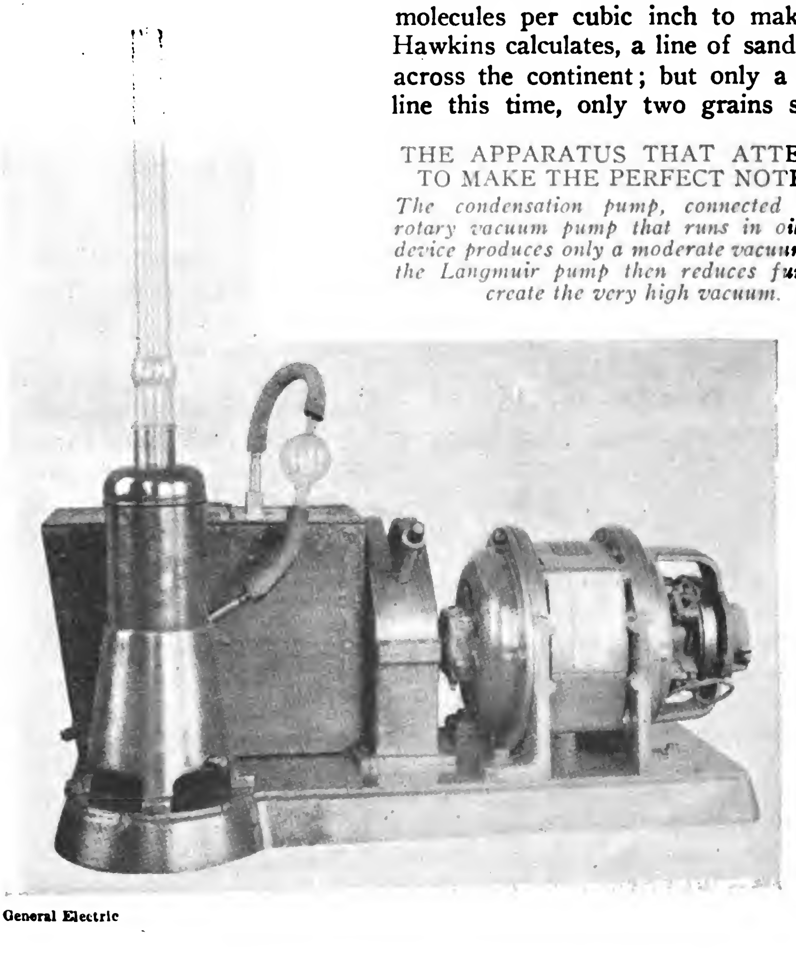
ever produced, the last word of science in perfect vacua. It is the highest vacuum known to man, a vacuum obtained only after years of research and after overcoming the most extraordinary experimental difficulties. And yet, with the best that science can do, there are still one hundred and thirty billion gas molecules inside a tiny two ounce tube. Each man, woman and child in the world could take away, out of this "empty" bulb, a flock of eighty little air molecules for personal pets. Nothing could give you a better idea of the almost inconceivable minuteness of those molecular sizes.

Even in the "empty" bulb the mathematical totals are astonishing. Only those who can remain undizzied on top of the tallest mathematical peaks will dare to calculate how many pet molecules could have been provided from the original air-filled bulb before 9,999,999,999 ten-millionths of these molecules were pumped out and thrown away.

A novel way of getting at the visualization of these staggering molecular totals is due to Mr. L. A. Hawkins, one of the engineers of the General Electric Company. Suppose, he says, each air molecule enlarged to the size of a fine grain of sea-sand, one hundredth of an inch in diameter, the molecules in a cubic inch of ordinary air would make a beach extending from New York to San Francisco, one thousand feet wide and over ten feet deep. This is for a cubic inch, about one-half of the air in an unexhausted radio tube. After exhaustion to the highest attained vacuum there are still enough air molecules per cubic inch to make, Mr. Hawkins calculates, a line of sand grains across the continent; but only a double line this time, only two grains side by

THE APPARATUS THAT ATTEMPTS TO MAKE THE PERFECT NOTHING

The condensation pump, connected with a rotary vacuum pump that runs in oil. This device produces only a moderate vacuum which the Langmuir pump then reduces further to create the very high vacuum.



General Electric

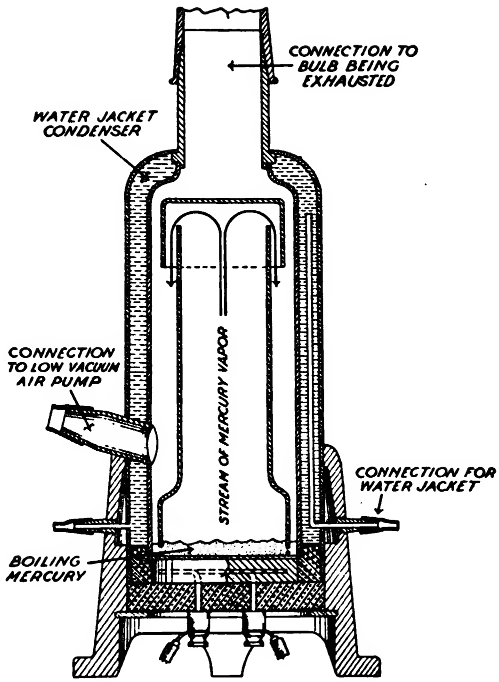
side, instead of the thousand foot beach.

Inside the ordinary commercial radio tube there are many more air molecules than this. The most perfect attainable vacua are not necessary for ordinary work and, because they are very expensive to produce, they are not used. All that is necessary is a good vacuum, a vacuum perfect according even to the scientific standards of twenty years ago, but considerably less perfect than the vacua now attained for important scientific researches. The ordinary commercial tube is exhausted to about .00001 millimeter of mercury, corresponding to about one hundred-millionth of an atmosphere. This means that there are left in the tube about one hundred times as many air molecules as are in the bulb which we talked about above, the bulb exhausted as highly as possible. In the ordinary tube the molecules total over thirteen trillions. But this is still too few to interfere with the operation of the tube.

First, however, let us see why a vacuum in the tube is necessary at all.

As every radio fan knows, the operation of the vacuum tube depends upon electrons, which are little particles of electricity. These electrons fly off from the hot filament of the tube, cross between the wires of the grid and hit the plate. The passage of the electrons causes an electric current to flow between the plate of the filament and the charge on the grid affects the strength of this current. The tube serves, therefore, to detect or to amplify changes in the potential of the electric charge on the grid. Everything depends on the electrons. If they do not fly off properly from the hot filament and pass across to the plate, the tube will not work.

Air molecules left in the tube, or any kind of gas molecules left in it, affect the behavior of the electrons in two ways. *First,* they interfere with the flying off of the electrons from the hot filament. *Second,* they cause what is called "ionization."



THE LANGMUIR PUMP

The device used for creating a vacuum in the tubes used in radio. This diagram illustrates the construction of the metal form of pump.

Proper electron emission from the filament, their continual flying off in sufficient quantity, requires a clean filament, a surface of metal freely exposed for the electrons to get out of. If there is much gas in the tube, some of the gas molecules attach themselves to the surface of the filament and keep the electrons from getting out, much as crawling moths or flies will stick to the surface of an outdoor lamp at night and keep the light from getting out. A little gas in the tube does small harm, just as a very few flies would interfere scarcely at all with the brilliancy of a lamp. And ten or fifteen trillions of molecules is really very few, considering their very small size. Millions of them could crowd together on the point of a needle. In comparison with a molecule, the surface of the hot filament is a broad and empty plain.

Ionization works differently to affect the electron current. When an electron

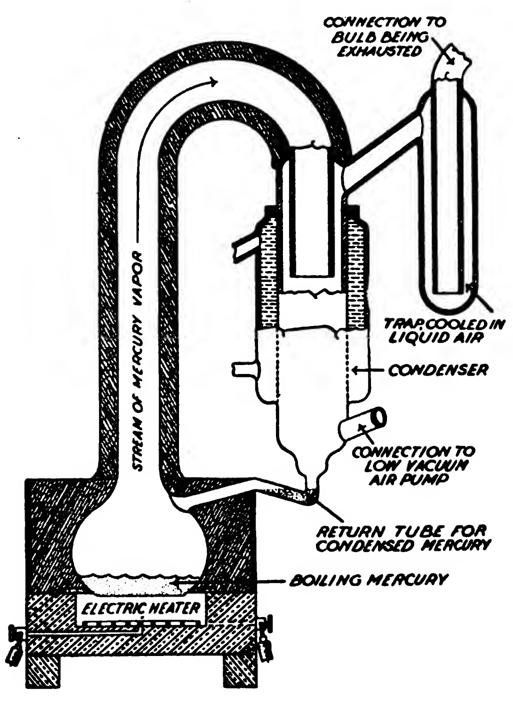
flies off from the hot filament it is moving very rapidly; speeds up to 60,000 miles a second have been observed. In an assemblage of gas molecules such a fast moving electron behaves exactly like a high-power cannon ball in a crowd of people. Presently the electron hits a gas molecule and when it does it knocks the molecule apart. Frequently it knocks another electron out of the molecule, for electrons, remember, are contained in all molecules, in the gaseous ones as well as in the metalic molecules of the filament.

A gas molecule which has been assaulted in this way and has lost one or more of its electrons is called an "ion." From the viewpoint of this article an ion has one especially important property. It carries a predominating positive electric charge, whereas the charge of the electron is negative. These positively charged ions set up, therefore, an electric traffic reverse to the traffic of the electron current. The electrons are negative. They move from the filament to the plate. The gaseous ions are positive. They tend to move from the plate toward the filament. This causes all kinds of confusion. The traffic gets into a snarl and the tube ceases to work properly—to work properly, that is, as a radio detector or amplifier. There are certain other kinds of tubes, such as a rectifier tube, used in changing alternating current into direct current, in which the presence of ions inside the tubes is desirable. Such tubes are filled with nitrogen or with the rare gases argon or neon. But in ordinary radio tubes ions are troublesome; consequently the less gas in such tubes the better they work.

It is not necessary, however, to have absolutely no gas. The few trillion molecules inside the ordinary tube do no harm. They are so scarce, relatively, that the electrons, which themselves are far smaller than a molecule, seldom hit them. The crowd is too thin. The cannon balls go through without doing any real damage. In the ordinary tube there is not enough ionization to do any harm. In the very best vacua there is practically no ionization at all.

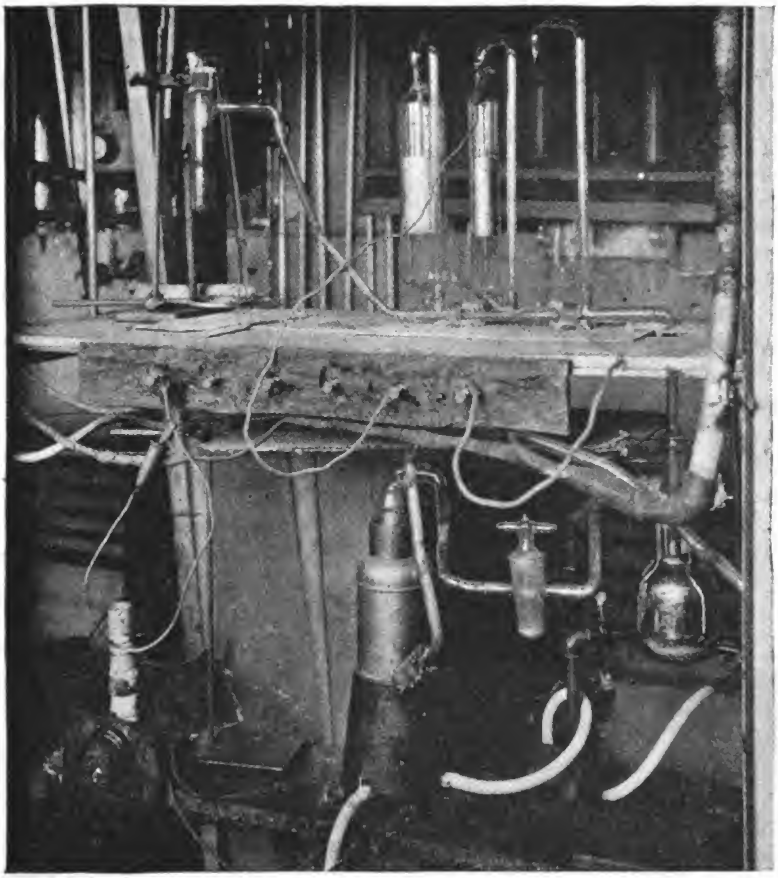
These very best vacua, including the record vacuum of one ten-billionth of an atmosphere, have been made possible by an apparatus developed by Dr. Irving Langmuir of the Research Laboratory of the General Electric Company. It is called the Langmuir condensation pump. The principle of this pump is very similar to that of the ordinary steam injector used to draw water into steam boilers. In these injectors a blast of steam is blown through a nozzle in a pipe filled with water and directed into the boiler. As the steam blows out of the nozzle it picks up some water and carries it along into the boiler.

An analogy which is more familiar, even if not quite so similar in scientific principle, is the way in which water running out of a bathtub will suck the air down with it through the tub outlet. The



HOW THE PUMP WORKS

A sectional view of the Langmuir apparatus for producing the vacuum in the triodes. This form is constructed of glass for laboratory use.



General Electric

MAKING THE HIGHEST KNOWN VACUUM

The Langmuir pump in actual use, creating an almost-perfect vacuum in the electron tubes seen on the work bench. At the right is a thermos flask containing liquid air, to cool the tube connecting the pump and the bulb that is being exhausted.

stream of running water entraps some air and takes it along down the pipe.

In the Langmuir pump, instead of a stream of steam or of water we have a blast of gaseous mercury, of the vapor from boiling quicksilver. This blast of mercury vapor blows out of a nozzle into a glass tube connected to the bulb from which we wish to draw out the air. As the blast of mercury vapor blows along through the tube it takes some air with it, entangles the air molecules in the great crowd of mercury molecules and drags them along. The farther part of the glass tube is kept cold. The hot mercury vapor condenses to liquid mercury and is returned, as a liquid, to the little heater which serves as a boiler. Here the liquid mercury boils away again and supplies new mercury vapor to keep up the blast.

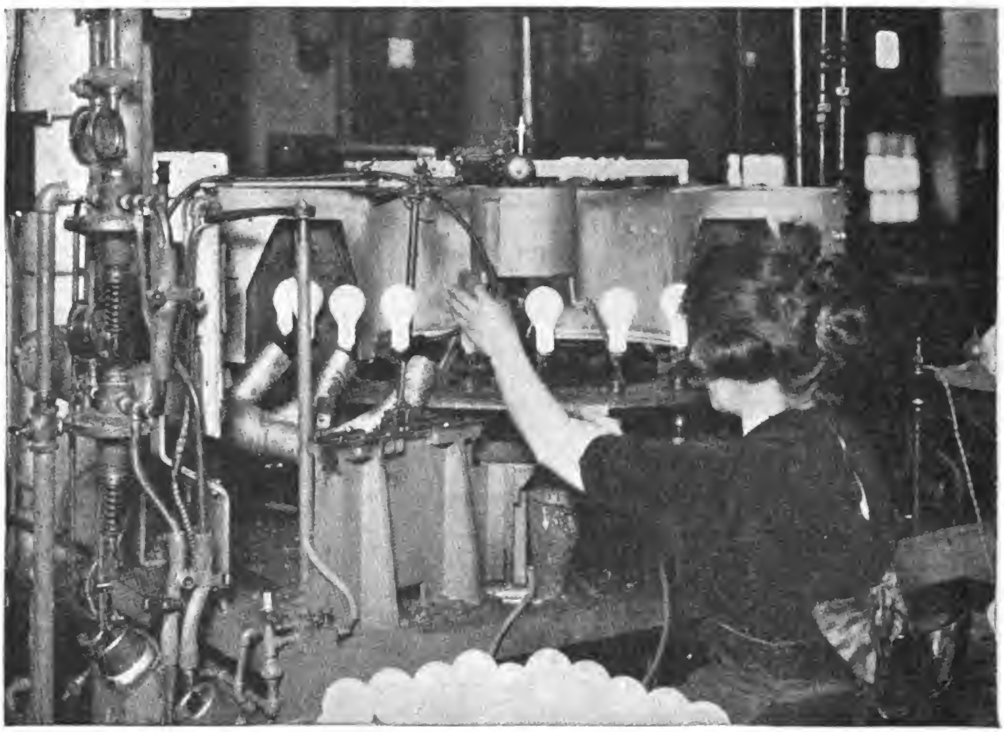
But the molecules of air which were with the mercury do not condense. They have been carried out of the tube and they stay out. They cannot get back in, against the blast of mercury molecules, any more than one man can make headway against a running crowd.

There are some practical precautions necessary in using the Langmuir pump. For instance, a part of the tube which connects the pump with the bulb to be evacuated is cooled in liquid air, cooled to a temperature of about 290 degrees Fahrenheit below zero, or even lower.

This freezes and keeps out any mercury vapor which might otherwise get back into the evacuated bulb and produce in it an atmosphere of mercury gas; for mercury does make a gas, though a very thin one, at ordinary temperatures.

Another great experimental difficulty which has to be overcome in high-vacuum work is due to the gas which is given off from the glass walls of the bulb, from the metal filament and from anything else which may be inside the bulb. The experiments of Dr. Langmuir and of Dr. Saul Dushman have proved that everything contains a great deal of gas. For instance, air will penetrate into solid glass, into solid metal, into nearly everything else. Physicists call this gas *adsorbed gas*. When a glass bulb is evacuated this adsorbed gas comes off slowly—boils slowly out of the glass or metal or whatever is inside the bulb. It may take days or weeks for all of this gas to come out. Indeed, it is probable that it never *all* comes out, that a little of it is always left —inside the solid matter of the glass or metal.

Of course this adsorbed gas, as it comes gradually out of the glass walls of the bulb, spoils the vacuum in the bulb. To get around this, the bulb, the filament and everything else is heated in a furnace as hot as it is possible to heat it without softening the glass. While hot, the bulb is exhausted by the pump. This is repeated many times until as much of the adsorbed gas as possible has been cooked out. Even then they never get quite all of it. A little will come out later for months, probably for years. This is one reason why an absolutely perfect vacuum has not yet been attained.



General Electric

CREATING VACUUMS IN THE LITTLE BROTHERS OF THE RADIO TUBES

On this rapidly moving machine ordinary lamp globes are exhausted on the turntable that carries them through the oven; as they come out (at left) they are cooled by three blasts of air.

These are some of the ways in which Nature fights against the perfect vacuum. So far Nature's efforts to prevent man from attaining the perfect vacuum have been successful. But there is one way in which Nature helps. This is the phenomenon called the "clean-up."

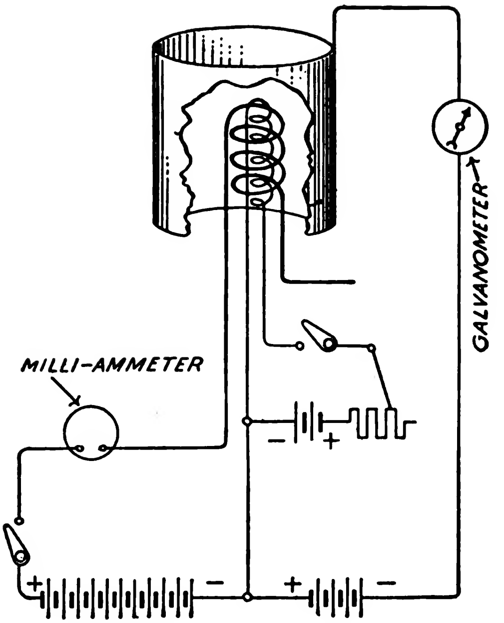
It was observed years ago that when a tungsten-filament electric lamp, like an ordinary mazda lamp, was burned for a while the degree of vacuum inside the lamp globe increased. Some of the air which had been left in the globe when it was made disappeared on use. The gases were "cleaned up"; hence the name of the phenomenon.

The scientific reasons for this clean-up have now been investigated. There are believed to be several ways in which it happens, in which the gas molecules are got rid of. Some of the molecules combine chemically with the metal of the filament, others with the materials of the glass wall or of something else inside. Many of them, Dr. Dushman thinks, are ionized by collision with electrons and are then shot off so violently, either by the mere collision or by electrostatic repulsion, that they penetrate deeply into the glass wall of the bulb and stay there, just as a bullet shot against a plank will go in and stick. Some of these ionized molecules may be shot at the glass wall of the globe so fast and so powerfully that they go clear through into the outside air and get away altogether.

The clean-up helps us toward a perfect vacuum; but it has not, as yet, enabled us actually to attain it.

Will science ever attain a perfect vacuum? What can we expect from continued research? Science is accustomed to hope and try for absolutes; the perfect conductor, the absolute zero of temperature, the ultimate particle of matter. Can we look forward to the attainment of an absolutely empty space?

Who knows? Recently there came prospect of help from an unsuspected quarter—from the Army's investigations



HOW GAS PRESSURES ARE MEASURED

Connections for the ionization gauge used in measuring small gas pressures. Electrons are produced by the inner hot-wire filament and pass across to the outer filament; these electrons ionize the gas in the tube and the positive ions are collected by the surrounding molybdenum cylinder. The number of positive ions is measured by the galvanometer and is proportional to the number of gas molecules in the tube.

on gas masks. An essential part of the gas mask was the powdered charcoal contained in the little tin box called the canister. The duty of this charcoal was to absorb certain of the poisonous gases. It was found, in studying this, that charcoal absorbed all gases, and the scientists of the Chemical Warfare Service were able to prepare, before the armistice, certain special kinds of charcoal which were hundreds of times better as gas absorbers than ordinary charcoal is. These special charcoals have been tried by Dr. Dushman as means of removing the last trace of gas from high vacua. They promise to work very well.

Perhaps something of this sort, used in connection with the Langmuir pump, will give us before long a still nearer approach to Nature's traditional abhorrence, a space containing nothing at all.

From a heretofore unpublished photograph

←*Sir Arthur Conan Doyle, the famous spiritualist, and Harry Houdini (professionally known merely as "Houdini") are close friends—as this snapshot indicates. "I respect Sir Arthur for the sincerity of his beliefs in spiritualism," states Houdini. "But I do not share them."*

Ghosts that Talk —by Radio

An Exposé of Some of the "Spiritualistic Phenomena" Perpetrated by Fraudulent Mediums for Getting Money from Their Credulous Followers

By
HOUDINI

The author of this article is the president of the Society of American Magicians. All the members of that exclusive organization are pledged to keep inviolate the tricks of their profession—except when those tricks are used for dishonest purposes. Houdini (who in order to study "spiritualistic phenomena" once entered the ranks of the professional mediums himself) properly considers those mediums dishonest who claim that voices transmitted by confederates by low frequency induction or "inductive radio" are the voices from the dead. He is, accordingly, as a public duty, disclosing in this article how these tricks are performed.

MAGICIANS have used the radio telephone in their performances for several years—long before radio was generally known to the public. I am not at all surprised that the radio is being used by fraudulent mediums to convince their patrons that they are in direct communication with the dead.

I regret profoundly to admit that in over thirty years of investigation, during which time I have attended hundreds of seances with a mind ready and eager to discover some sign from those who have gone to the Great Beyond, I have never witnessed anything that I could accept as evidence that there was life beyond the grave. All the "evidence" that I have seen is merely phenomena that are well known to the average magician. What are "wonders" to the average human being are merely everyday tests that are familiar in the profession. In performing some of these experiments I have myself seen men and women faint away, overcome with what they thought were supernatural occurrences. As a matter of fact I was merely performing more or less common tricks.

The passing away of my mother first started me on a serious investigation of the doctrines and claims of the spiritualists. Only those who have lost their loved ones can know the fervor with which such investigations can be pursued. There is no sacrifice I would not make to be able to get in communication with my mother. After years of research I still hope that there is a way of communicating with her from this life. But I have no faith in the existing forms of communication as known to mediums or practised by them at the present time.

There is not the slightest doubt in my mind that such men as Sir Oliver Lodge and Sir Conan Doyle are sincere in their beliefs. They regard spiritualism as a religion; to them it is something sacred. They think that the evidence they have

obtained is sufficient evidence to justify their faith in their "communications" with those who have passed beyond. I respect them for their sincerity. But I do not share their beliefs.

I have made definite compacts with seven intimate friends and relatives to the effect that the one who died first would communicate with the others. All of my seven friends are dead. Up to the present time I have not received the slightest sign from any of them. In order to get into communication with them I have gone to seances conducted by famous mediums. Yet I never received any sign that was not obviously a trick on the part of the medium—a trick with which I was thoroughly familiar.

The human senses are easily deceived. People believe what they want to believe. The human being is always seeking something in which he can put his faith. A combination of deception and faith is capable of leading human beings to almost any extreme of self-delusion. It is the business of the mediums to capitalize this faith.

I exposed a medium in Bochum, Germany, twenty years ago by throwing ordinary carpet tacks under his bare feet when he came out to the audience in a dim light and posed as a spirit from another world. Today I would need a radio receiving set to uncover his latest deception. Before attending this seance I had been repairing one of my cabinets and had a number of tacks in my pocket. I casually threw them on the floor before the curtain in front of the opening whence the ghost of Cæsar was to appear and lecture. The medium who impersonated Cæsar stepped upon the tacks and burst forth into a profusion of German oaths.

From a photograph made for POPULAR RADIO

THE FAMILIAR TRUMPET OF THE SPIRITUALIST MEDIUM

Only in this case the instrument is fitted with (A) a telephone receiver that converts the received current into sound and (B) a receiving coil that collects energy from the transmitting coil, which may be hidden some yards away—all concealed in false sides. (C) is the orifice through which the voice issues. The medium's confederate may be located several yards away.

Radio has given the "spirit business" an enormous boost in the last few years. While the rest of us have just been getting acquainted with it, many of the so-called psychics have been reaping a harvest.

I love an honest-to-goodness trick that mystifies and entertains me. It is my business to know them all and to try to perform them better than other magicians. As President of the Society of American Magicians, numbering over 1,000 members, it is my duty to hold such tricks; indeed, we have all taken an oath not to reveal them. But concerning the deceptions of fraud mediums—that is another matter. I regard it as the duty of every thinking man, whether or not he believes in spirits, whether or not he believes in God, to expose imposters who profane the concepts of future life merely to extort money from believing souls who in their ignorance misplace their confidence,

A total of $300,000 was extorted by one clever medium from Luther B. Marsh (the law partner of Daniel Webster) in 1888 by the use of a primitive radiophone. Her name was Ann O'Delia Dis Debar, and she made a spectacular career for herself until she was exposed in court by Alexander Herrmann and Carl Hertz.

There have been countless other swindles through the invention which has been practically unknown up to the present time. The device was little more than ordinary telephone by induction in most cases, but in the more intricate deceptions the principles of modern wireless telephony were employed.

I have the largest library of magic in the world. It was while trying to buy books that I read of the auction of a well-known medium in New York, and the day before the sale I bought all of her books and bound volumes of the publication, "Medium and Daybreak." I was shown a kettle, and as I knew that the kettle was used by mystifiers, bought this also.

The device was a "talking kettle." When the proper "spiritual connections" had been established by the medium, through her facial and bodily contortions in the approved "psychic manner," the kettle became most intelligent. Anyone in the room could ask the kettle a question and receive an intelligent answer at once by placing the spout of the kettle to his ear. The answer would come in a whisper, a most ghostly whisper, such as is familiar to those who have attended spiritualistic seances.

That same kettle is now installed in my home and it talks to my friends in the same kind of whisper with absolutely no change except the replacement of the battery. Sane men of prominence in public life, men who should by all means suspect me of trickery, have actually been deluded by this simple device.

There is no doubt in my mind but that I could cause a great many people to believe that spirits speak through the medium of the kettle; in this way I could merchandise spirit messages for substantial sums of money.

The kettle can be handled and carried about the room while it is whispering, turned upside-down and otherwise explored.*

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*While the author does not feel at liberty to describe the operation of this kettle, the explanation of it is obvious. The secret lies in the radio receiving apparatus that is concealed in its hollow walls. The kettle is made of *papier-mâché*, so that it will not absorb the radio waves which are intended for the aerial coiled inside. The medium who operates the kettle or similar radio device must have a confederate in an adjoining room, who hears everything through a sensitive microphone concealed in the room where the seance is held.

One of the best devices for concealing such a microphone is an oil painting, a painting made on gauze rather than canvas. By placing a deep shadow box over the picture the thin gauze is made to look like canvas. The shadow box acts as a resonator for the sounds in the room and the thin gauze enables the sounds to pass to the microphone with but little obstruction.

The confederate in an adjoining room may thus hear every question that is asked in the room and make his replies by radio. The transmitting wireless instruments are placed in the room with the confederate, but the transmitting antenna is concealed in a rug directly beneath the kettle. This arrangement makes it necessary for the radio waves to travel only a few feet to reach the receiver in the kettle, so that not much power is required for transmitting.

With modern improvements in radio, the kettle may be carried to any part of the room, and with the sensitive microphones they are making today, the slightest whisper can be heard by the confederate who may be elsewhere in the building, or even at some distant point.—EDITOR.

From a photograph made for POPULAR RADIO

ANOTHER COMMON "PHENOMENON"—THE TALKING IMAGE

The voice of the medium is transmitted to the confederate in another room by the ordinary microphone. The confederate's reply is transmitted into another microphone that is connected with a transmitting coil concealed in a rug (or other object). This energy is collected by the receiving coil in the statue and is converted into sound waves by the telephone receiver concealed in the image's head.

Sometimes my friends ask questions in such a low tone of voice that I cannot hear them; they are, accordingly, completely converted to the belief in spirits when the kettle answers. This "spirit-talking" kettle has been used by mediums for years; it is the invention of David Abbott, who devised it for purposes of entertainment only.

To the best of my knowledge the first application of the principles of radio to spiritualistic manifestations was in 1852, when Jonathan Koons, a farmer of Dover Village, Ohio, installed a "spirit machine"—described as a "crude structure of zinc and copper for localizing and collecting the magnetic aura."

This radio telephone trick is per-

From a photograph made for POPULAR RADIO

THE "SPIRIT" LISTENS AND SPEAKS

The ears and mouth of the "talking" objects are merely microphones in the hands of the medium's confederate—who may even be in another building.

formed in many ways. Statues of Buddha are among the popular bits of property employed by mediums; they are made to answer questions as glibly as hollow balls and trumpets.

In my collection of old clippings from magazines and newspapers, I find a description of the trick reported in the *Gazette de France* some years ago. The pages are yellow and the printing is old fashioned. The story concerns "The Invisible Girl" who mystified all Europe. To quote the article:

> In a small chamber in this house is seen a chest of white glass suspended from the ceiling by four little chains, which keep it perfectly separated from every other thing. This chest is transparent and penetrable to the eye in its whole extent. To one of its extremities is adapted an opaque tube or horn, by which a voice is heard; the voice appears to be that of a young girl, who replies distinctly to every question put to her.
>
> The impression of breathing and the heat of the air of respiration (impregnated with the odor of liquors which she has taken) are also perceived.
>
> I thought at first that this voice was that of a ventriloquist, and that it was the voice of him who showed the curiosity. But on the morrow my astonishment was extreme, when this pretended ventriloquist went out of the chamber with another, and, when I put new questions with a voice so low that I was not heard by any of the other spectators, to find that the replies were perfectly applicable and well articulated.
>
> If it be said that magnetical or electrical virtues are introduced for some purpose in the operation, we would ask how it happens by any of these virtues that the Young Invisible sees and names, without ever being deceived, the object which is held in the hollow of the hand, such as a piece of silver, the surface of which is held up to the orifice of the tube in such a manner that these objects cannot be perceived from any other point.
>
> We concluded that perhaps there was in the chest a really invisible girl, a dwarf much smaller than that of the King of Poland. This dwarf died in 1764. A wooden shoe served it a long time for a cradle. At six years old it was 15 inches high, at sixteen years it was 29 inches high. History speaks of a dwarf who at thirty years of age was only 18 inches high. It belonged to Queen Henrietta of France.
>
> If this is the fact, the dwarf must be only from twelve to fifteen inches in length and above five or six in thickness, this being all the space of the chest which cannot be seen, it being behind the communicating tube.
>
> The questions we put to the Invisible Girl and the replies which it made are as follows: *What age are you?* "Fourteen." *Where were you born?* "At Marseilles" (she has an accent absolutely provincial). *What is your name?* "Francoise." *Are you pretty?* "No." *Are you good?* "Yes, though sometimes ill-natured." *What is your position in this chest?* "I am reclining." *Do all the questions which are put to you disgust you?* "Never, but I am sometimes very much wearied."
>
> Although I could not discover the solution of the mystery, I would rather believe it to be a dwarf than any other thing.

This ancient and sceptical reporter would not believe the invention to be magical, but if he were living now, a good medium could make him think it spiritualistic. In reality the "Invisible Girl" was a full-grown woman.

A description of this trick is illuminating as illustrative of the methods of the fraudulent mediums even in those days. John Wyman, one of our well-known old time magicians, copied it from an early publication and put it in his book which was published in 1851. The device consisted of four upright posts, united by bars or nails at top and bottom. From the corner posts four wires bent in ogee form converged and terminated in a crown ornament. From these wires a hollow copper ball about one foot in diameter was suspended by four short, slender ribbons. The ball thus suspended was fitted with four copper trumpets pointing at right angles, with their bells directed to the side top-bars. The ball was simply hung in space by the ribbons, and trumpets were fixed in suspension along with the ball. The voice was conveyed to the flaring bells of two of the horns by a speaking tube concealed by one of the corner posts; then at right angles along the top bars to points directly at the center of two trumpet bells.

Questions were asked by spectators, who spoke into the bell of a trumpet which conveyed the message by the speaking tube to the lady assistant concealed in an adjoining room. Her answer was conveyed back by the same speaking tube. The voice was weak in volume and discernible only to those listening attentively at the four trumpets. The effect was that which might conceivably come from a small "Invisible Girl." The woman confederate was in a side room with a peep-hole through which she was able to see her dupes and make pert remarks about them. A signal system was also operated between the "person who attended the machine" and the concealed operator. The whole "machine" was so simple in construction that it appeared perfectly portable and movable to any part of the room.

It is interesting to note that as far back as 1784 mediums were using various means of transmitting the voice for

From a photograph made for POPULAR RADIO

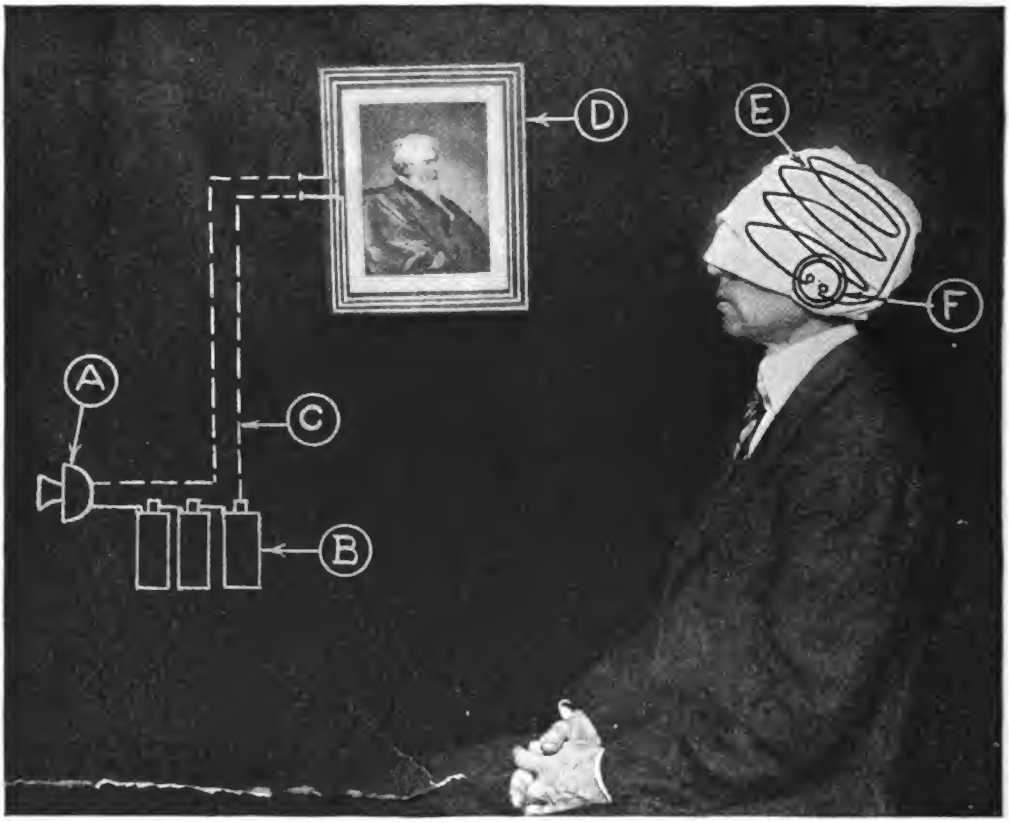
THE SECRET OF THE KETTLE

The receiving coil hidden in false sides collects the energy sent out from a transmitting coil that may be several yards away, and this energy is converted into sound by the telephone receiver in the spout.

mysterious effects. Radio has vastly increased their facilities.

The fraudulent mediums today are merely using various adaptations of the "Invisible Girl." Instead of being in an adjoining room she is now so far away that she cannot hear the questions asked without the aid of a microphone concealed in the wall. Even at a considerable distance an opera glass, properly focused on the spot, serves the purpose of the peep-hole.

With an induction coil coupled in the circuit with her telephone transmitter and batteries, she now sends out strong enough impulses to affect the sensitive receiver with a loop aerial concealed inside the horn. This was, indeed, the first form of radio telephone. It employed the same principles of induction



From a photograph made for POPULAR RADIO

IN COMMUNION WITH THE "SPIRITS"—PLANTED IN ANOTHER ROOM

Still another variation of the inductive radio trick. (A) is the microphone into which the distant confederate talks; (B) are the batteries that furnish current over the concealed wires (C); (D) is the transmitting coil concealed in a picture frame; which transmits the energy to (E), the receiving coils, that are connected to (F) the telephone receiver over the medium's ears.

without wires as the modern complicated radio apparatus, and it worked almost as well over a distance of a hundred feet or more. The trick is a pretty one and would do credit to any magician, but it has fallen into the hands of unscrupulous psychic performers and consequently, because it is used for getting money under false representations, it should now be exposed.

With more modern apparatus and the pretense of spiritual communication, this simple illusion is now deceiving thousands and defiling the concept of life after death.

Perhaps you who are reading this article may attend the seance of a medium as clever as the woman who became nationally famous as a result of her work one evening in a western city. While she was in the midst of her communion with the shades of those present, she stopped short.

"I see a man murdered!" she exclaimed. Then she described a violent death scene, giving the name of the man and the address in the city where he was actually murdered a few minutes before she received the "spirit message." The newspapers confirmed her statements and later spread her fame throughout the country.

From that time on people paid ridiculous prices for her services—until she was exposed.

The secret of her spiritualistic demon-

stration was simple. A radio antenna in the sole of her shoe received impulses from a transmitting antenna in the rug upon which she stood, and conveyed them to a sensitive head phone hidden in a large bouquet of flowers on her shoulder. A reporter had telephoned the news of the murder to her confederate behind the scenes, who transmitted it by radio telephone. The receiver concealed in the flowers was not loud enough for the audience to hear, but when the medium leaned her head upon the flowers she could hear it distinctly.

Her feat was a blow she had been aiming at sceptics for some time. She had placed her reporters at police stations, hospitals and newspaper offices to wait for the news of a death by violence which would receive space in the papers.

You understand this particular type of medium now, and are sure you will not be fooled—but suppose you should meet the statistician-medium? She wears a phone over one ear and a complete aerial and receiving set is concealed beneath a heavy wig, or it is concealed in her hair.

She stands under a chandelier which hides the transmitting antenna, or perhaps walks near a picture from which the radio waves issue. If she is a good radio engineer, she may have a set so sensitive that she can place her transmitting antenna in another room. Your name rolls off her tongue, as soon as you enter. She tells you all about yourself, she seems to know as much about you as your intimate friends.

"Your mother will be here shortly," she remarks, casually, although you had not told her your mother was dead and that she was the one you wished most to be near.

Many a man has fallen a victim of such mediums, for he had no way of knowing that confederates had looked up his history while he was waiting for the interview, and telephoned it *via* radio. The medium offers proof that he or she has not left the room to receive information, and thereby he gains a few more gullible customers for his illicit traffic.

A few years ago, while going to Europe on the *Imperator*, I was asked to entertain with an informal seance. I had for my guests Theodore Roosevelt, Victor Herbert and other prominent men. Roosevelt wanted to know if I could tell him where he spent his last Christmas Day. I had a slate with a "spiritual" covering, and in a few moments, with the slate apparently before their eyes continuously, a map appeared upon it, made with a dozen colors of chalk. It indicated the exact spot where he had been on the "River of Doubt" and was a duplicate of the map he intended soon to publish in a book. The name of W. T. Stead, the English writer lost on the *Titanic*, was signed below the map; it was recognized as Stead's own signature. I had never seen the map and I was unacquainted with the signature.

"Is that really spirit writing?" Roosevelt asked with deep concern.

I am sure I could have won his confidence by this slight test. But I replied:

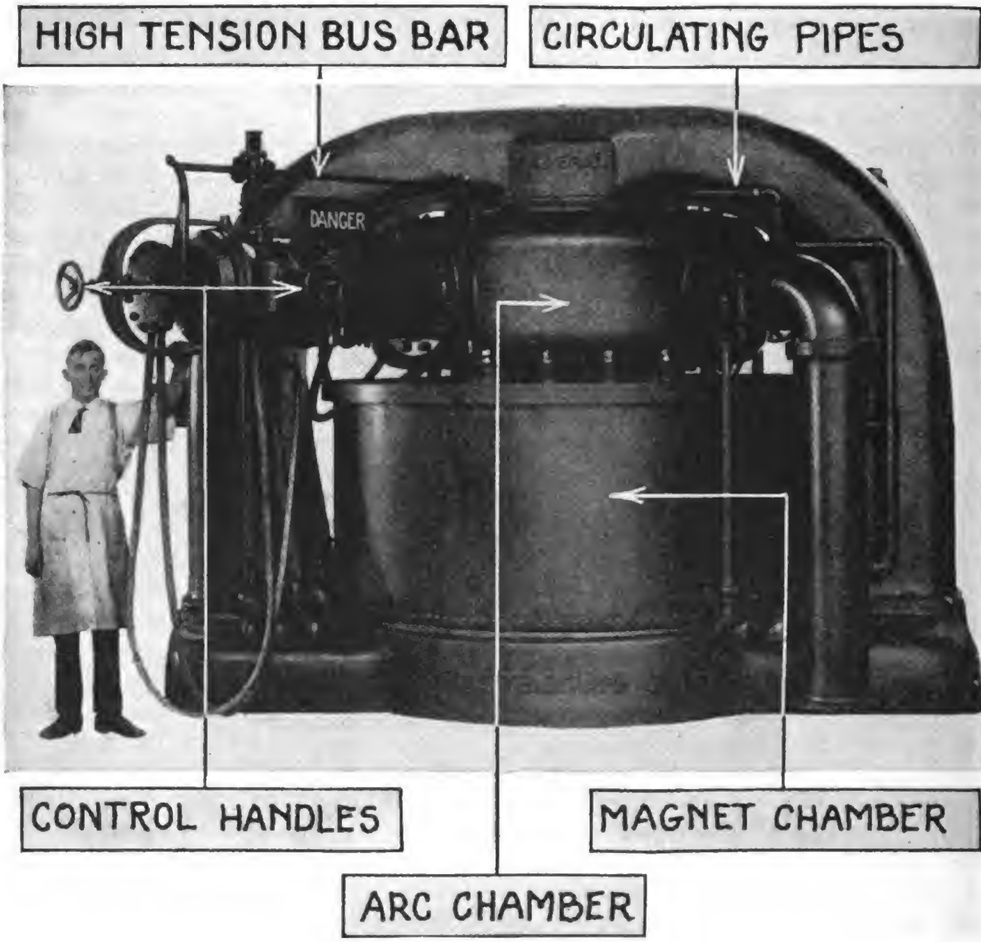
"No, I am simply a mysterious entertainer. Everything I do can be explained by natural means as illusions."

When it is so easy to deceive a highly developed mind, it is easier to fool ordinary people, and especially those who are anxious to believe.

In many instances self-hypnotism is the secret. The medium suggests things, catches the mind off guard, and the moment after it has been surprised he follows up with something else which carries the intelligence along even against the will.

Radio at present is the greatest aid to the fraud mediums, and they are sure to take advantage of every new development. I hope that spirits will talk to us through radio instruments some day, but I will prefer to hear such messages in a scientist's laboratory rather than through the presentations of unscrupulous mediums.

If there are mediums who are not fraudulent, I have yet to see them.



THE GRANDFATHER OF ARC TRANSMITTERS

This huge arc converter has long been used in trans-Atlantic telegraphy. It employs 1,000K.W. of power—ranging from 200 to 500 times as much as is used for the new type of transmitter described in this article.

THE NEW AND COMPACT

"Panel Arc Transmitter"

By CHARLES R. LENTZ

THE first arc transmitters designed for use on ships were cumbersome affairs, as every experienced marine radio operator knows. They occupied as much space as the first spark transmitters. The old arc chambers were designed on a generous scale, and with the auxiliary equipment just about filled the all too limited space of the vessel's radio cabin.

This unwieldy apparatus is now being replaced by a new and compact machine known as the panel transmitter, which can be included in a space 6 feet high on a floor space measuring only 24 by 20 inches for both the 2 K.W. and the 5 K.W. sizes.

This space may include the motor generator, but it does not provide for the water cooling tank or for the lightning switch.

As the result of practical and persistent experiment, an apparatus has been developed that is automatic in its operation; to switch from sending to receiving is but a matter of pressing a lever.

The auxiliaries and motor generator are designed for a 110-volt direct current supply, the usual source aboard ship, while the radio frequency portion is designed for an average ship antenna that has a capacity of approximately .002 mfd., with an average fundamental wave length of 440 meters and a high frequency resistance of 6 ohms at 600 meters.

Four wavelengths can be used by adjusting one switch, the transmitters generally being adjusted to 600, 1800, 2100 and 2400 meters. However, the 2 K.W. units have one high wavelength less than the 5 K.W., and provision is made for a 300-meter instead of the 2400. This is required by law.

For receiving with non-oscillating equipment, a modulating device is used which allows damped wave transmission at 300 and at 600 meters.

As shown in Figure 1, the upper panel is confined as far as possible to high frequency apparatus and leads. The open section in the center carries the arc chamber, the gas pressure regulator, the modulating device, the water pump and the carbon rotative mechanism; the two latter mechanisms are driven by the same motor. The lower control panel contains all the low tension and high tension direct current devices and leads.

Figure 2 shows a complete schematic wiring diagram of the transmitter and its auxiliaries. The ship's mains are brought to the panel through the main fused switch.

After the set is wired, and with the Send-Receive switch turned to "send," operations may proceed as follows:

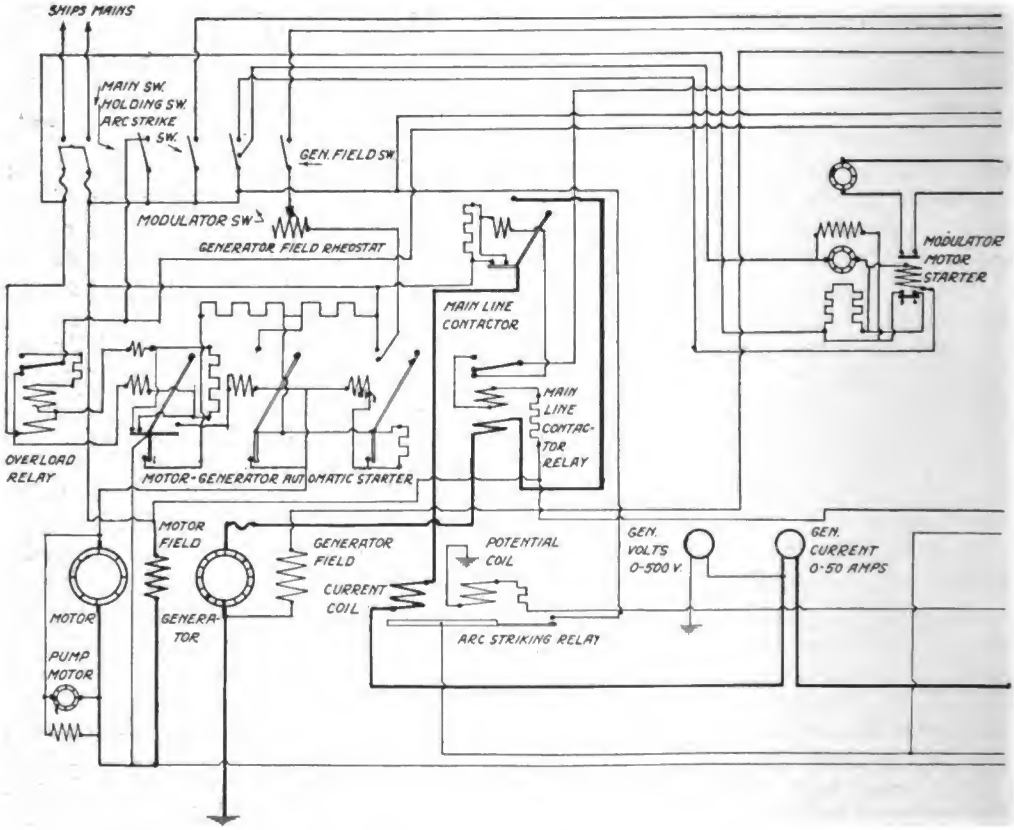
1. The motor generator is brought to full speed by the automatic starter, which is of the current relay type.
2. The generator field circuit is closed.
3. The main line (generator) circuit is closed.
4. The water circulating pump and the rotating carbon device are started.
5. The potential coil of the arc striking relay operates, closing its secondary contacts; this in turn closes the circuit to the arc striking solenoid.
6. Before the cathode (carbon) is drawn in to strike the anode, the starting resistor is connected in series with the arc and with the generator.
7. As soon as the arc is struck, the hydro-carbon magnetic needle valve automatically operates and the cathode slowly draws away from the anode, the proper action being regulated by an oil dash pot. At the same time the current coil of the arc striking relay predominates over the potential coil and the secondary contacts of the relay open again, allowing the cathode to withdraw from the anode. Again the starting resistor is shorted, and the arc is allowed to draw full power.

It is hardly necessary to describe the action in the high frequency circuit; the arc is of the Poulsen type and has been well covered in a number of text books.

In the 110-volt leads an overload relay is provided; when the current in the circuit is abnormal it flows through the current coil of the relay and this draws up an armature, breaking the circuit. The armature is held by a potential coil and cannot be released without disconnecting the ship's mains from the panel.

A relay similar to the overload relay is inserted in the generator leads, but in this case an overload opens the main line contactor (solenoid type), and this opens the positive side of the generator line.

The normal full load voltage of the 5 K.W. unit is 375 volts, variable by a generator field rheostat, and the normal full load current ranges from 12 to 15 amperes. Meters are provided with read-



ings in generator volts and amperes; the product of these two readings gives the arc input in watts.

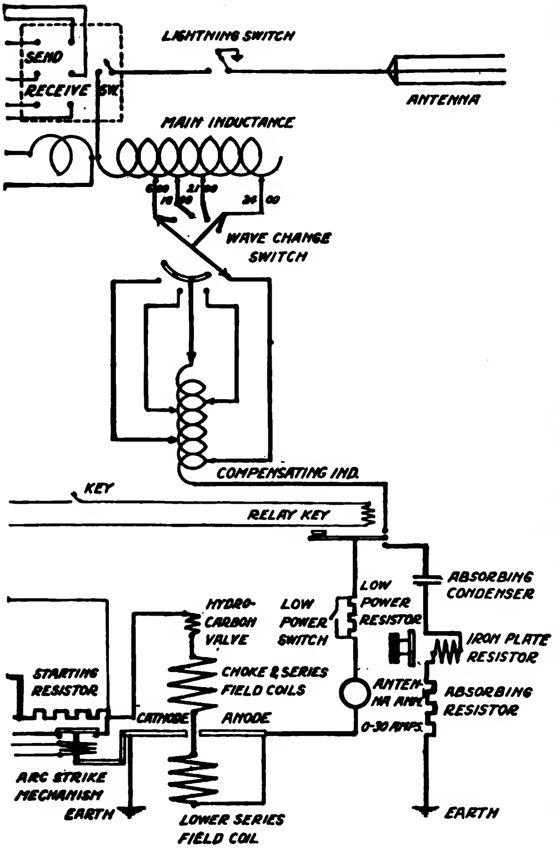
A radio frequency meter ranging from 0 to 30 amperes for the reading of antenna current is also provided. At 1800 meters a fair antenna current would be 18 amperes, assuming a 5-ohm high frequency resistance for the antenna. The antenna input would be of approximately 1620 watts, with an arc efficiency of approximately 30 percent.

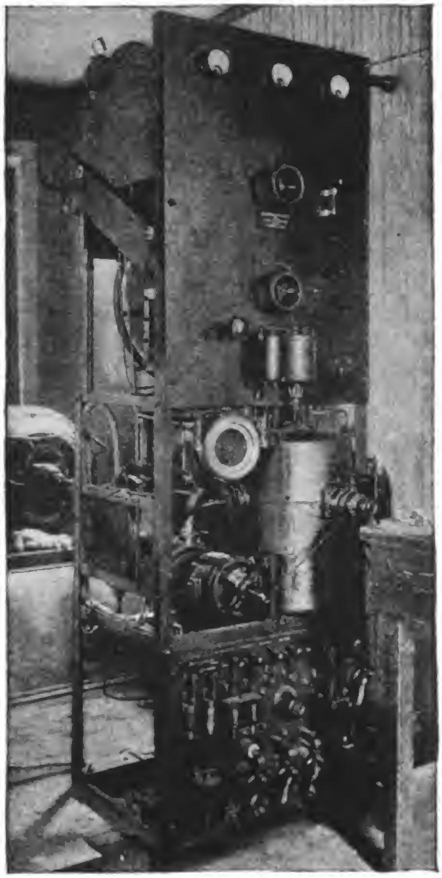
The arc chamber is cast in two pieces. These are split about one-third of the way down, and in them are screwed the pole pieces. A watercooling duct of one complete turn is cast in the main chamber section.

The field coils are wound in four sections, one in the upper portion and three in the lower portion. They are wound with square cross-section asbestos-covered copper wire, and are connected in series. Additional insulation in the form of empire cloth insulation is provided between coils and chamber.

Connected directly with the chamber, and at ground potential, is the cathode, its distance from the anode, or arc distance, regulated with a control handle. The cathode holder can be removed instantly from the chamber, and a new carbon may be inserted without tools.

The anode is, of course, insulated from the chamber. It consists of a solid copper tip held by a large copper tube. Within the large tube is a smaller one, also of copper. The water from the cooling system enters through the small tube, plays directly on the solid tip and returns through the large tube. Then it goes through the one-turn duct in the chamber back to the cooling tank and from there to the circulating pump. During a period of continued use, carbon will collect in the arc chamber; this may be





WILL THIS NEW TYPE OF APPARATUS REPLACE THE SPARK TRANSMITTER?

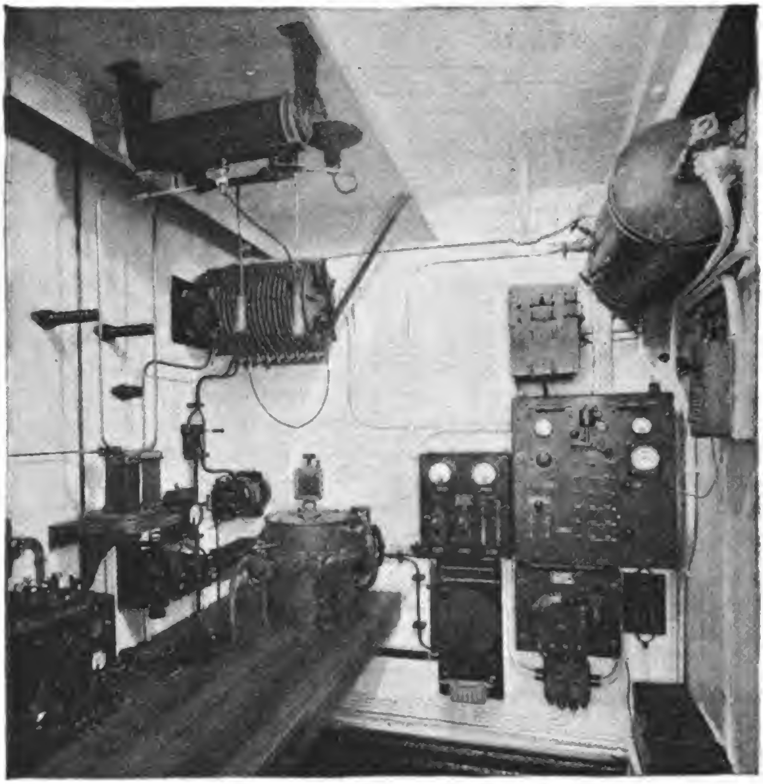
Diagram of apparatus wiring and picture of the new type of arc transmitter that bids fair to replace the troublesome spark transmitter now commonly used for ship-to-shore communication. The set can be used on low wavelengths and can transmit either continuous waves or modulated continuous waves by merely turning a switch. The modulated signal has a musical note of a frequency of 400 cycles a second. The set is capable of transmission over long distances.

cleaned out when the anode is removed.

Hydro-carbon is supplied to the arc by vaporizing alcohol; when the alcohol drips on the hot electrodes it automatically vaporizes. The pressure of the gas in the chamber is kept constant automatically by a regulator that has a diaphragm similar to that in an ordinary gas meter, and poppet valves are provided to prevent dangerous explosions. It has been found that when this gas is supplied to the arc it tends to keep the oscillations stable and allows the arc to handle a greater amount of power.

Unlike the high-powered arc transmitter, this set does not emit a "compensating wave." Signalling is accomplished by switching the anode terminal from an absorbing circuit to the antenna circuit, and when the key switches the anode lead the anode must always be connected with either or both of these circuits in order to sustain the arc.

The absorbing circuit consists of a condenser, a resistor, and an iron plate resistor, the complete circuit having approximately the same characteristics as the average antenna.



THE ORDINARY ARC TRANSMITTER INSTALLATION ON SHIPBOARD
The apparatus in this case is a 2 K.W. arc transmitter on the U. S. S. VULCAN. *The cabinet in the lower left corner contains the receiver; all the rest of the apparatus scattered about the cabin are the various parts of the arc equipment. Contrast this arrangement with the compact arrangement shown on page* 111.

The iron plate resistor is a variable unit, and it is possible to adjust the absorbing circuit so that it will draw exactly the same input as the antenna circuit. In other words, when signalling, the anode is first connected to the absorbing circuit and then to the antenna circuit; the arc input remains constant as indicated by the meters.

The transfer key is of the relay type and is remotely controlled by a single telegraph key at the operating table. An auxiliary handle protrudes through the panel so that the transfer key may be operated directly by hand in case of an emergency.

To change wavelengths with an arc transmitter it is only necessary to vary the amount of inductance in series with the antenna, or to vary the antenna constants. In this case the desired change is reached by inserting the proper amount of inductance in series with the antenna. The main inductance consists of a large Bakelite-Dilecto tube, wound with a heavy Litzendraht wire nearly 3/8 inch in diameter. The inductance is wound in sections and the sections are bank wound. Taps are taken off at every section.

It is apparent that fine wavelength adjustment is not possible when the inductance is varied by taps in every section, so a compensating inductance is provided. This consists of one flat spiral of strip copper, which can be varied by a handle on the front of the panel.

There is in the wavechange switch a total of eight positions for the four wave-

lengths, the extra position for each wavelength cuts in the compensating inductance for fine adjustment.

For example, if the desired wavelength is 2,400 meters, the wavechange switch is turned to the right "half" portion of 2,400 meters and the wavelength is measured and found to be 2,600 meters. Another section of inductance is cut out of the main inductance, increasing the frequency and the wavelength is then found to be 2,356 meters. Next, the compensating inductance is increased and the wavemeter read, the frequency decreasing until the wavelength is increased to exactly 2,400 meters. A permanent clip is then substituted for the variable contact and that contact is used again to adjust the other wavelengths.

To produce damped oscillations a modulator system is used. This consists of a few turns of heavy Litzendraht wire in inductive relation to the main inductance. These turns are periodically short-circuited by a special commutator which has a certain number of bars connected together. When current flows through the main inductance and these turns are shorted, the wavelength is decreased approximately 7½ percent. The speed of the commutator and the number of common bars were selected to give a 400-cycle note, while the resulting decrement is just enough to provide sharp tuning and yet insure being heard when transmitting.

If the operator wishes to reduce his power when he nears land, he may insert a 10-ohm resistance in series with his antenna, or he may reduce his arc input.

The water cooling tank has a sight level glass and controlling valves, and is usually mounted on the bulkhead with a casting provided for the purpose. Water connections are made with a special hot water hose, and in winter alcohol is mixed with the water to prevent freezing. Of course salt water can never be used as it would short-circuit the anode to the ground.

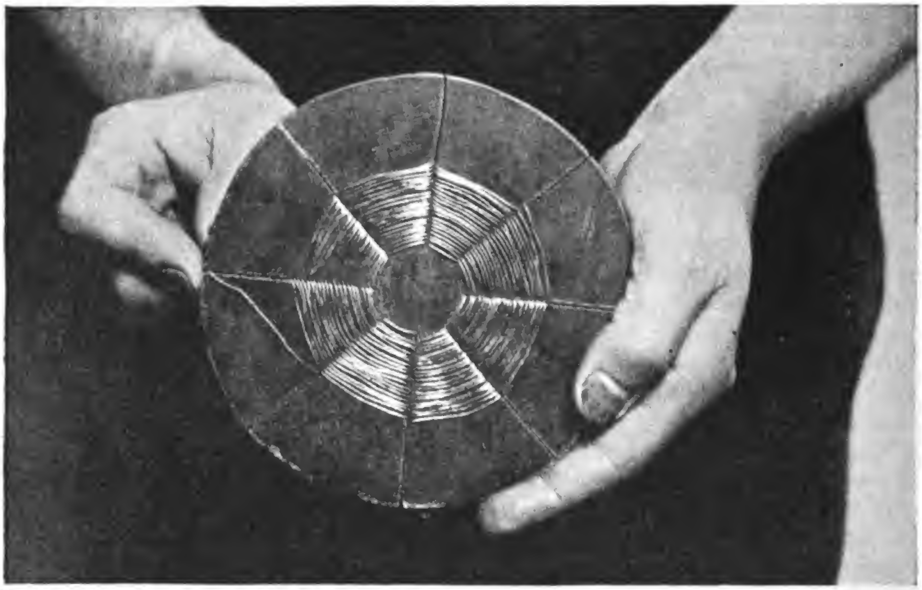
Excellent work has been done with these new transmitters. A 5 K.W. unit installed at Babylon, N. Y., when radiating only 8 amperes at 2,100 meters was reported by a tug stationed in the harbor at Hamilton, Bermuda. The tug had a standard Navy receiver with a two-stage amplifier and reported that the signals were readable ten feet from the phones.

Another unit installed on the S. S. *Minnekarda* has worked the Cuxhaven Station at distances approximating 2000 miles. Cuxhaven uses a quenched spark gap.

The designers of the improved transmitter, Messrs. Shoemaker and Farrand, have made a distinct and valuable contribution in the field of nautical communication.

Are There No Ether Waves?

THE *now-famous article by the distinguished American physicist, Dr. Charles P. Steinmetz,* THERE ARE NO ETHER WAVES *(which was first published in* POPULAR RADIO *for July,* 1922) *has stirred up the proverbial hornets' nest in scientific circles both here and abroad. So seriously has it agitated the physicists of England, indeed, that they have turned to the greatest living English authority on ether to make a reply to Dr. Steinmetz—Sir Oliver Lodge, who has devoted the larger part of his life to a study of this subject. Sir Oliver's response will appear in our next issue—NOVEMBER.*



From a photograph made for POPULAR RADIO

THIS HOME-MADE COIL COSTS LESS THAN 50 CENTS

To make this device (sometimes called a "spider-web coil"), requires no special tools or unusual skill. This article gives complete instructions that every novice can understand.

How *to* Make a SPIDER-WEB TUNER

The Sixth of a Series of Practical Articles that Tell the Amateur How to Build His Own Apparatus

By A. HYATT VERRILL

THERE are many forms and types of loose-coupled coils and vario-couplers. While almost any form will serve as a tuning device for ordinary sets and while there is comparatively little difference in their efficiency if they are so arranged that equally fine adjustments may be made, yet for some types of regenerative sets a tuning device with a third or tickler coil may be used to good advantage.

To construct an ordinary vario-coupler with a rotor as a tickler is not a hard task, but the results obtained from home made instruments are not always all that is desired, largely because they are merely makeshift contrivances.

A type of vario-coupler which gives really excellent results, yet at the same time is simple and easy to make is composed of three flat, circular coils known as "spider-web" or "pancake" coils.

No great skill or experience is needed to make this and no unusual tools are required; the materials necessary are few and inexpensive; indeed, a first-rate coupler of this sort may be made at a cost of less than two dollars.

The only tools needed are a screw-driver, hack saw, 1/4, 1/8, and 1/32 inch drills, a pair of compasses or dividers and a soldering set; in addition a set of screw taps and dies will prove useful. It is advisable for anyone who intends to

make radio sets or instruments to purchase a set of taps and dies; they are not expensive and they soon pay for themselves many times over, especially if time is of any account.

For materials, you should have binding posts (such as may be taken from old dry batteries); some strip brass ½-inch wide, and ⅛-inch thick; some 1-inch by ⅛-inch brass screw-headed bolts with nuts and washers to fit; a couple of 2-inch by ¼-inch bolts of the same type; a supply of No. 22 or 24 cotton or silk-covered copper wire and enough Formica, Bakelite or other composition sheet ⅛-inch thick to make three discs each 6 inches in diameter.

First, draw a circle 6 inches in diameter on a sheet of heavy white paper or thin bristol board or cardboard. With your dividers or compasses mark off nine equal spaces around the circumference as shown in Figure 1. Then, with a straight edge, draw lines from each of these points to the centre of the circle, as shown in Figure 2. Next draw a second circle 2 inches in diameter as shown in Figure 3.

Now cut out the large circle and cut a slit from each of the marks along the radiating lines to the edge of the 2-inch circle, as in Figure 4. These slits need not be wide; 1/32 of an inch will do. Now, using this slotted circle as a template or pattern, place it upon the ⅛-inch sheet of composition sheet and with a sharp steel point or a pencil mark the outer circumference of the circle and each slot upon the composition sheet. Make three of these and then with your hack saw cut out the discs. If you have any difficulty in making good circles don't be discouraged, but try making the discs nine-sided by cutting straight across from one radiating mark to another, as shown by the dotted lines in Figure 4.

When the three discs are cut out, saw along each of the marks indicating the slots (making a single cut), and finally bore a ⅛-inch hole through the exact centre of each disc. Also, bore two 1/32-inch holes in each—one hole just inside the inner end of one of the slots and the other hole near the outer circumference close to a slot, as indicated in Figures 4 and 5. Thread one end of the wire through the inner hole on one disc, leaving six or eight inches free, fasten it with sealing wax and commence winding. Wind the wire from the hole up through a slot, across one of the

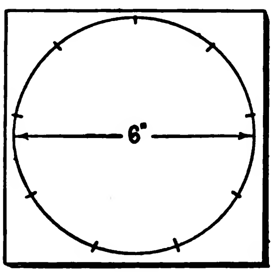


Fig. 1

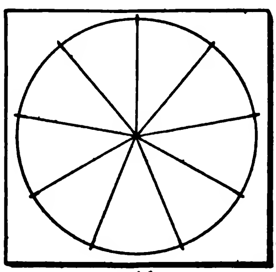


Fig. 2

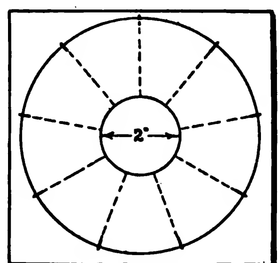


Fig. 3

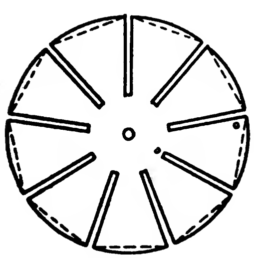


Fig. 4

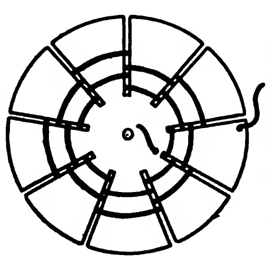


Fig. 5


Fig. 6

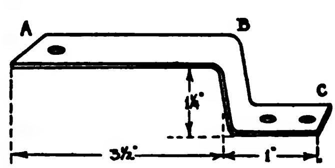


Fig. 7

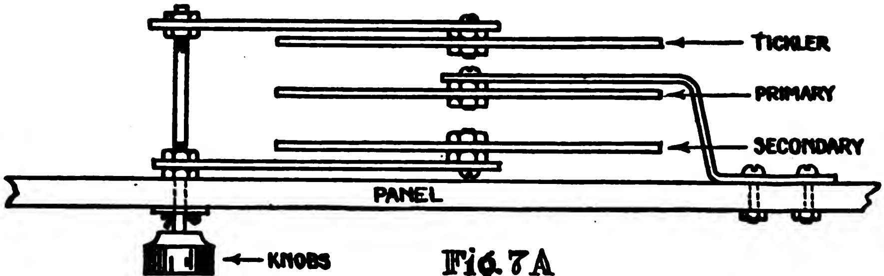


Fig. 7A

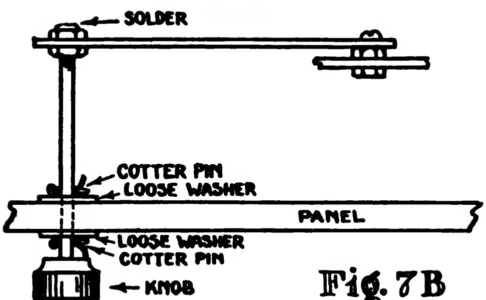


Fig. 7B

"blades" down through the next slot, across the next blade, up through the next slot, across and down again, and so on, as shown in Figure 5, as if you were weaving the bottom of a basket. In this way the wire, as you wind it on, will cross on itself in the slots at every turn, as shown in Figure 6.

Wind on about 30 turns on one disc, pass the wire through the small hole near the edge, fasten it with sealing wax and cut it off so as to leave at least 6 inches free. Then proceed to wind the next disc, and be sure to wind in the same direction as the first; but put about 50 turns on this one. Do the same with the third disc, putting on 80 turns of wire, and the discs are then ready to assemble. But remember, when I say 30, 50 or 80 turns I mean *complete* turns; the wire should pass the starting point 30, 50 and 80 times.

There are two ways of assembling these coils; the one you select will depend partly upon the way in which it is to be mounted and the space it is to occupy and partly upon your skill. If the coils are mounted or assembled in one way, two coils are movable past the third or fixed coil in the same plane, whereas, if they are mounted in the other way, they move back and forth or towards or away from the fixed coil. It makes little difference which method is used as far as efficiency is concerned, although personally I think the latter method is a little the better. It is a trifle more difficult to mount them in this way, however, and they also occupy a great deal more space. As the first way is the simpler, I will describe it first.

Take a strip of ½-inch by ⅛-inch brass and bend it in the form shown in Figure 7, making the distance from A to B 3½ inches and the distance from B to C about 1 inch. Bore two ⅛-inch holes in this short end and another ⅛-inch hole in the opposite end, as illustrated.

Now secure the disc with the fewest turns, or the primary coil, to the end (A) of this strip by means of a short ⅛-inch bolt. First slip the bolt through the hole in the strip, then screw a nut on tightly, then place the coil over the bolt and screw a second nut on; then file the bolt end down flush with the surface of the second nut as shown in Figure 7 C. Secure this strip bracket that holds the coil to the

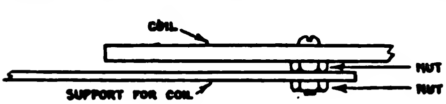


Fig. 7C

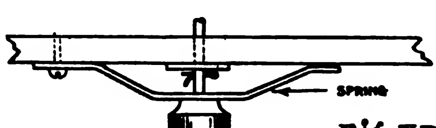


Fig. 7D

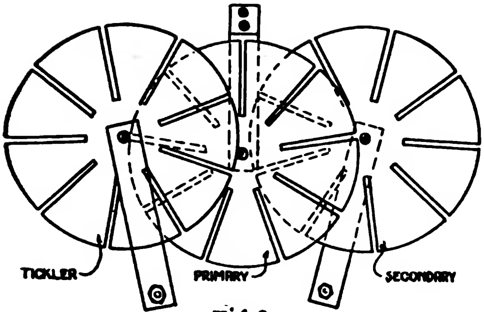


Fig. 8

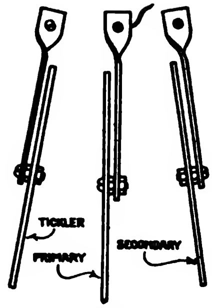


Fig. 9

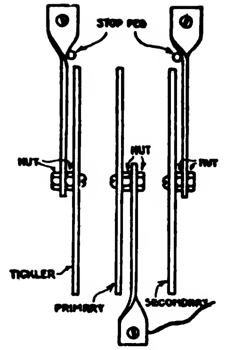


Fig. 10

panel or other support by means of two screws through the holes in the short end, as in Figure 7 A.

Now cut two more strips of the ½-inch by ⅛-inch brass, each 4½ inches long, and bore a ⅛-inch hole near one end of each strip and a ¼-inch hole through the other end of each. Fasten the other two coils to these strips—one coil to each strip—by means of screws and nuts through the ⅛-inch holes, exactly as you did with the first coil.

The next step is to mount these two movable coils in such a way that they may be swung into line with the fixed coil or swung away from it at will, as shown in Figure 8. The best way to do this is to hold one of the coils (the one with 50 turns of wire), against the primary or stationary coil and then mark where the ¼-inch hole comes on the panel. Then do the same with the coil that has 80 turns and bore holes through the panel where marked. As the 50 turn or secondary coil must swing between the primary and the panel and the tickler or 80 turn coil must swing the other side of the primary, it will be necessary to provide shafts of different lengths for the two. These may be long ¼-inch bolts secured to the strips fastened to the coils by means of two nuts (as shown in Figure 7 B), or they may be pieces of brass rod soldered to the strips. In this case you should place a washer both above and below the strip and solder washers, shaft and strip at one

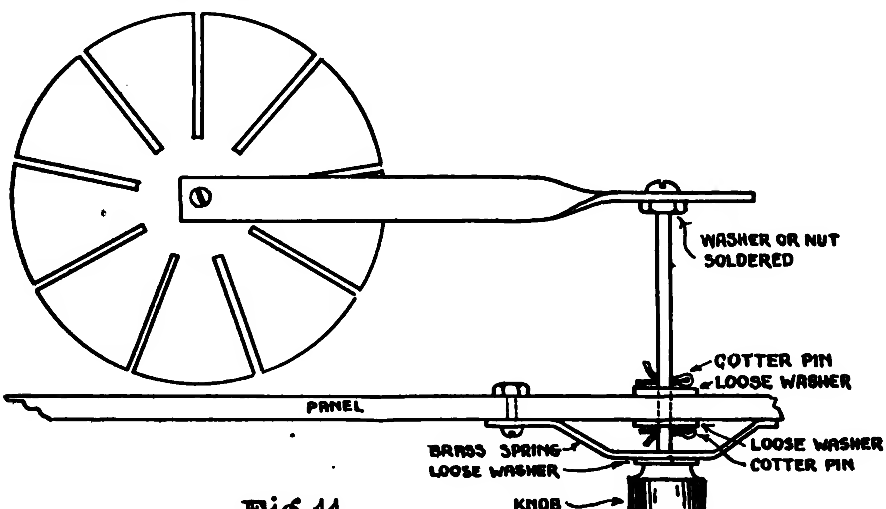


Fig. 11

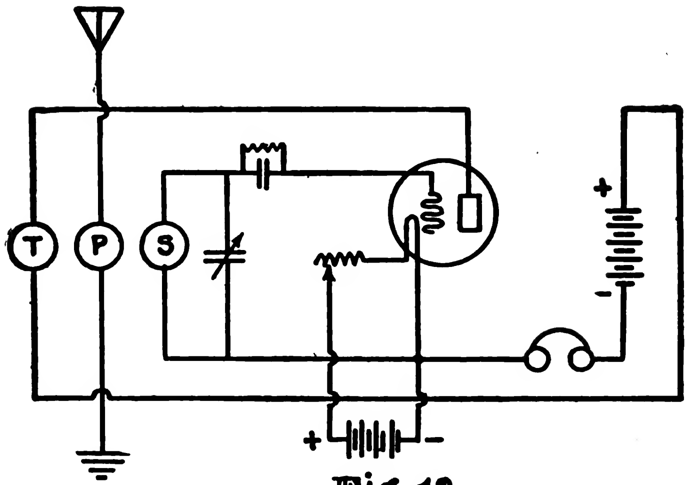


Fig. 12

time. If nuts are used it is also advisable to solder them in place so as to avoid any chance of their working loose. In fact all the nuts used in attaching strips to coils or to the panel should be soldered, as nuts and screws have a remarkable habit of working loose without apparent reason.

After the shaft is fastened to the strip it is an easy matter to pass it through the panel and arrange two loose washers, one on either side of the panel, secured either by small cotter-pins, or by soldering the washers to the shaft, so that the latter cannot move out and in. (See Figure 7 B). Then, when the coils are assembled in their proper positions, the rods should be cut off evenly on the outside of the panel and knobs of rubber or Bakelite attached to them.

You will find, however, that the weight of the coils and strips has a tendency to make the coils slip gradually out of position as set, even if the shafts fit tightly in the panel. This may be overcome by fastening a piece of spring brass to the panel and with an oblong hole in it through which the shaft passes. Then by forcing this down until there is quite a bit of pressure upon it and by fastening a washer or nut to the shaft against it (see Figures 7 D and 11), a steady pressure will be maintained upon the shaft and the coils will stay put.

The other method of mounting the coils is shown in Figures 9, 10 and 11. The coils are secured to strips of brass as already described, but each strip is twisted at right angles near the free end as shown in Figures 10 and 11. They are then attached to the panel and are mounted exactly as described, the only difference being that they swing in a different way. The details of attaching the coils to the strips and of arranging the shafts and bearings, as well as the spring tension, are so plainly shown in Figure 11 that no description or explanation is needed.

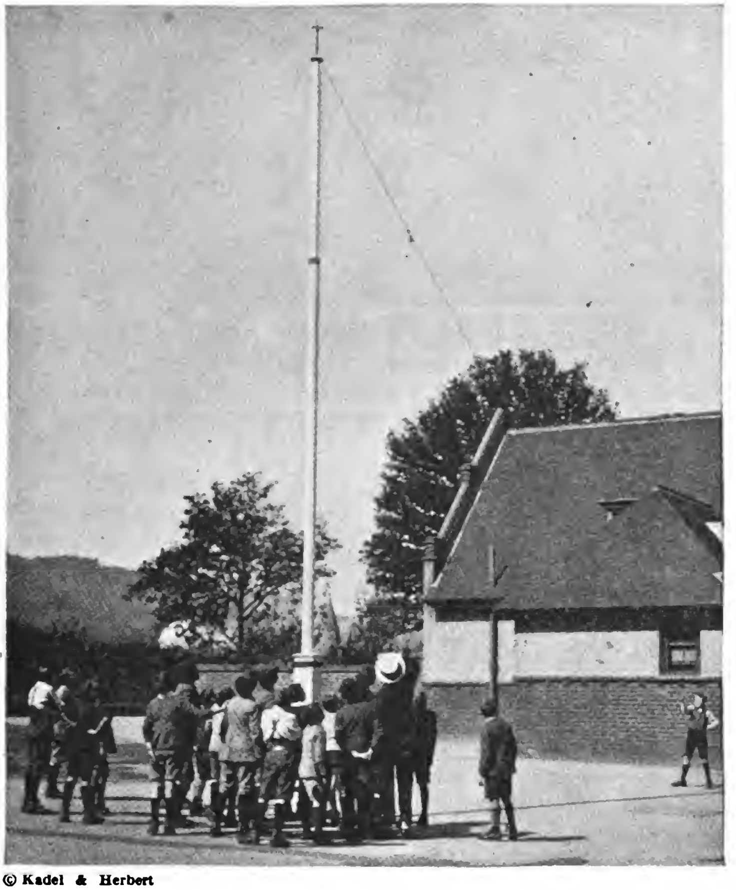
Finally, when the coils are assembled lead the end wires to the binding posts, using flexible wires for the movable coils; and when you connect the set, follow the wiring shown in Figure 12.

When you first use this type of variocoupler, place the coils so that all are in line, turn on the filament until it glows properly and adjust the variable condenser until you get the signals. Then move the coils slowly—first the secondary and last the tickler—until the interference disappears and the sounds you wish to hear come in clearly and distinctly. When the two coils are entirely away from the primary the shortest wavelengths are re-

ceived; if all three are brought close together the longest wavelengths possible for the coils are brought in. In case you should find that you cannot tune down to the shorter wavelengths you wish to hear, you may cut down the wavelength by taking a few turns of wire from the coils or place a variable condenser in series with your aerial. If you do the latter you will secure a far greater range of wavelengths than by taking off turns of wire.

MAKE YOUR OWN VARIO-COUPLER!

¶ In the next issue the author of this series of "How to Make" articles, Mr. Verrill, will describe in detail how to build a novel form of vario-coupler—a form that is of special interest to amateurs because of its peculiar combination of efficiency and simplicity of construction.



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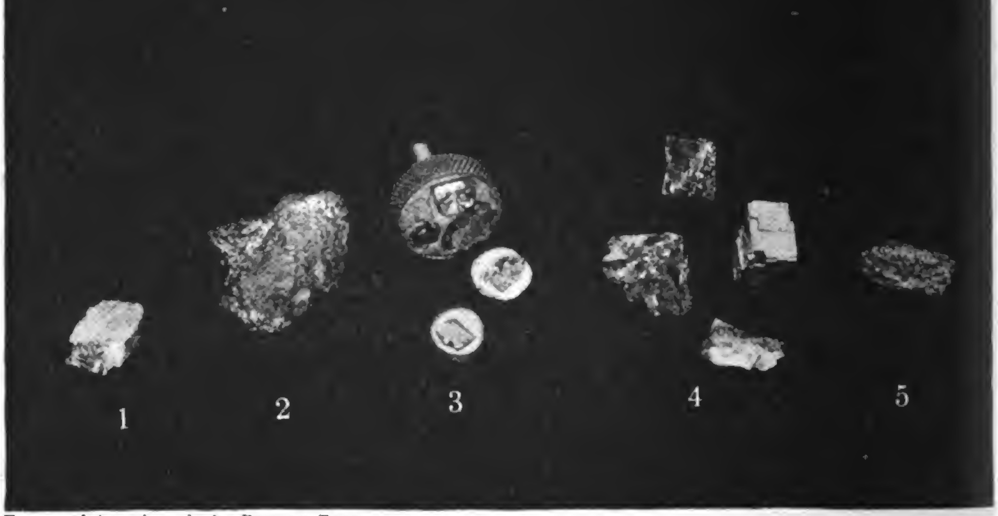
RADIO AS AN EDUCATIONAL FORCE IN THE SCHOOLS

It has been well said that "radio is making the United States a nation of scientists." Certainly no invention has so stirred the imagination of the American youth, or stimulated a more wholesome or more extensive study of electricity and of mechanics; even in England, where radio is but little known among amateurs, the subject is being taken up in the schools. What the schools are doing with radio will be told in succeeding issues of POPULAR RADIO.

How *the* Crystal Detector Detects

SIMPLE "HOW" ARTICLES FOR THE BEGINNER—NO. 6

By LAURENCE M. COCKADAY, R. E.



From a photograph made for POPULAR RADIO

FIVE OF THE MORE COMMON KINDS OF CRYSTALS USED IN RADIO RECEIVING SETS

No. 1 is a piece of pyrites; No. 2 is molibdenite; No. 3 shows three bits of crystal mounted in Woods metal settings for commercial use; No. 4 shows four pieces of the familiar galena crystal, and No. 5 is a silicon crystal.

THE antenna forms the means of transmitting energy through space without the use of wires; it is also the means of collecting this energy at a receiving station and reconverting it into electricity. The inductance, or coil, and the condenser are the means used for tuning the circuits which are connected to the antenna, so that the electric currents induced in the antenna may be led through these circuits to do work in producing some tangible result that may be used for signalling. In both radio telegraphy and radio telephony this result is sound.

The ordinary telephone receiver is a device that will change electricity into sound waves.

"But why," asks the beginner in radio, "do we need the detector at all when we have such a device as a telephone receiver, which is designed for this very purpose, to change electric currents into sound waves?"

It is true that this point is hard to fathom out by oneself without a little study.

In the first article of this series*, we delved a bit into the theory of wave motions and learned that sound waves had a certain frequency range. If a flexible reed were to be started into vibration, and the speed of vibration or frequency be increased, at first a low note is heard; as the frequency is increased this note steadily mounts upwards in pitch until it becomes a shrill whistle; finally the note becomes so high that we can no longer hear it. In other words, the tone goes up

* *See* POPULAR RADIO *for May, 1922.*

beyond the range of detection by the human ear.

The telephone receiver is designed to work on frequencies that the ear *can* detect. Like the human ear, its diaphragm will not respond to vibrations that are too high in frequency. Even if a special receiver were to be designed that would respond to these frequencies, we would not have solved our problem, for the ear would not detect them.

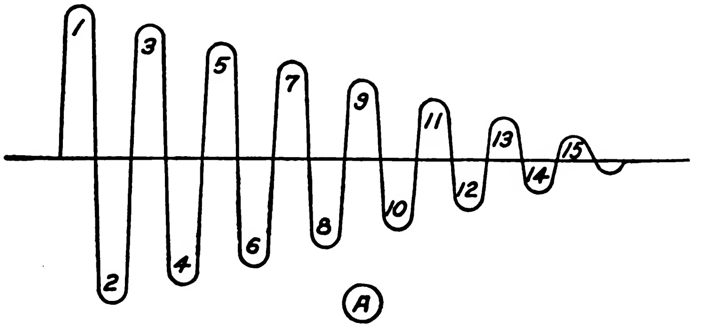
The electric currents that are used in radio are of a very high frequency—as many as millions a second. Now we see that this is the reason that they would not work the receivers in a radio set, and some other device would have to be used to lower the frequency of these currents before they could be used to energize the receivers and produce audible sounds.

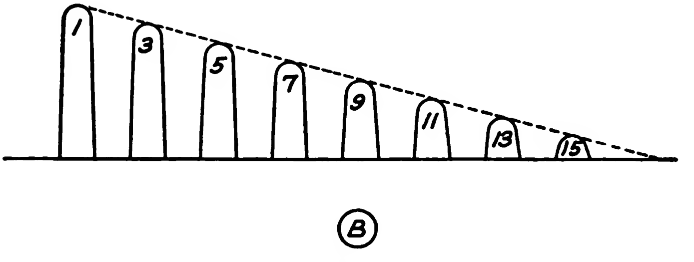
The telephones used for radio reception are generally designed to operate with maximum efficiency at a frequency of about 800 cycles a second; if a current of a frequency of over several thousand a second is led through the windings, they produce no sounds, as the diaphragm cannot move quick enough.

The diagram, Figure A, shows a series of high-frequency electrical oscillations such as are used in radio telegraphy. Notice that these follow each other, reversing direction after each impulse; first an impulse in one direction (numbered 1) which we may call a positive impulse, and then an impulse in a reverse direction (numbered 2) which is a negative impulse. These follow each other in such rapid succession that if they passed through the telephone they would produce no results, for before the diaphragm would have time to get started into motion in one direction, the second opposite impulse would be tending to prevent its motion, and so on indefinitely.

Here is where the detector comes to the rescue.

It was discovered some time ago that





RADIO IMPULSES BEFORE AND AFTER RECTIFICATION

The top diagram, A, shows incoming high-frequency impulses before they are rectified, and the lower diagram, B, shows the same impulses after they have been rectified by the crystal. Note that only the impulses in one direction remain; the others are choked back.

certain mineral crystals offered a great resistance to electric currents when these currents were led through them in one direction, but offered small resistance to currents that flowed through them in the opposite direction. This action is somewhat similar to the action that takes place in the valve of an automobile tire. Air may be pumped into the tire through the valve, but air may not pass out of the tire through the valve. The air may pass in one direction through the valve.

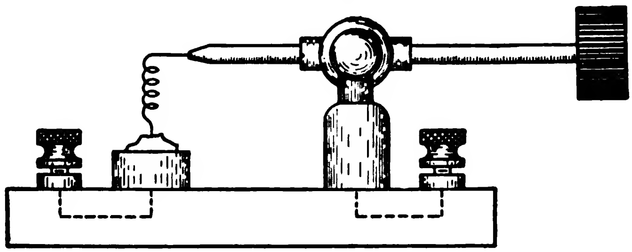
Somewhat the same thing happens with the crystal detector. The electric currents may pass in the one direction, but not in the other.

If a high frequency current such as shown in Figure A should be led through a crystal of this kind, only one-half the impulses would get through; those that flow in one direction would pass while those that flow in the other would not. This would allow a series of positive impulses (1, 3, 5, 7 and upward) to flow through the telephones, as shown in Figure B. These impulses flowing through the telephones in such rapid succession, and all of the same polarity, would act on the diaphragm as one large impulse such as indicated by the dotted line in Figure B. This impulse, extending over a much greater time than the smaller period impulses, would pull the diaphragm in one direction and this would make one single sound impulse. If a series of high frequency oscillations are generated in groups of a definite audio frequency at a distant transmitter and are received and "rectified" by the crystal as thus described, they will reproduce the same sounds in the receiving telephones as those produced at the transmitter. In this way the crystal prepares the received energy so that it can be used to work the telephones and our present day telegraphy and telephony is thus made possible.

Unfortunately, however, crystals do not have this rectifying quality throughout the entire surface; they have it only in spots, and it sometimes is an aggravating task to find the sensitive spot. For this purpose the crystal is usually mounted in a metallic cup, which is connected to a binding post; and a spring wire attached to an exploring arm, which is mounted on a universal joint, is used for finding the sensitive spot on the crystal. This arm is connected to another binding post. A detector stand of this type is shown in Figure C.

The knob on the end of the arm is slowly wiggled around until the spring point comes into contact with a sensitive spot on the crystal, when signals will be heard in the telephones—providing, of course, that some station is sending and the receiving apparatus is tuned to the particular wavelength that the station is sending out on. When we are trying to "set" or "adjust" our detector, if our set is not tuned to any other station's transmitting wavelength, we would never know if the detector were in adjustment or not.

A device which is of great help in adjusting a detector is known as a buzzer test, and this consists of a high tone buz-



THE ORDINARY CRYSTAL DETECTOR

FIGURE C: *The type of detectors generally known to radio amateurs. It consists of a cup for holding the crystal and an adjustable arm and spiral spring for finding the sensitive spot.*

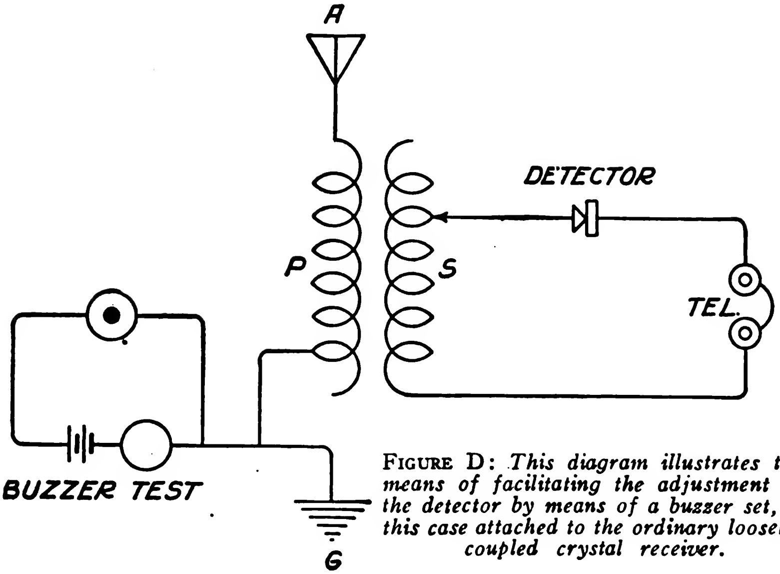


FIGURE D: *This diagram illustrates the means of facilitating the adjustment of the detector by means of a buzzer set, in this case attached to the ordinary loosely-coupled crystal receiver.*

zer connected in series with a dry battery and a push button. When this device is connected up (as shown in Figure D) with a receiving set that employs a tuning device (in this case a loose coupler, P and S) and a crystal detector and a pair of telephones, and the push-button is held down with one hand while the detector is adjusted with the other until the buzz is heard distinctly in the telephones, the detector is set without bothering about tuning for any outside signals; when thus set, the push-button may be released and the set be tuned with the assurance that if any one is sending within range of the receiver his signals will be heard.

There are numerous crystals that possess these rectifying characteristics to a greater or lesser degree, and these may be obtained at almost any of the regular radio stores.

Thus we can readily see that the detector is necessary in a receiving set after all, and can more fully understand what we are accomplishing when we adjust the little spring on our set that sometimes causes us so much worry and sometimes brings forth bursts of heated language.

In the next article we will take up the study of the vacuum tube as a detector, and point out its points of superiority over the crystal.

How to Perform Tricks with High Frequency Current

DO you know that you can send a million volts through your body without injury—provided you use a low current? How to entertain your friends with spectacular but harmless demonstrations of the phenomena of electricity will be told in POPULAR RADIO*—in a near issue.*

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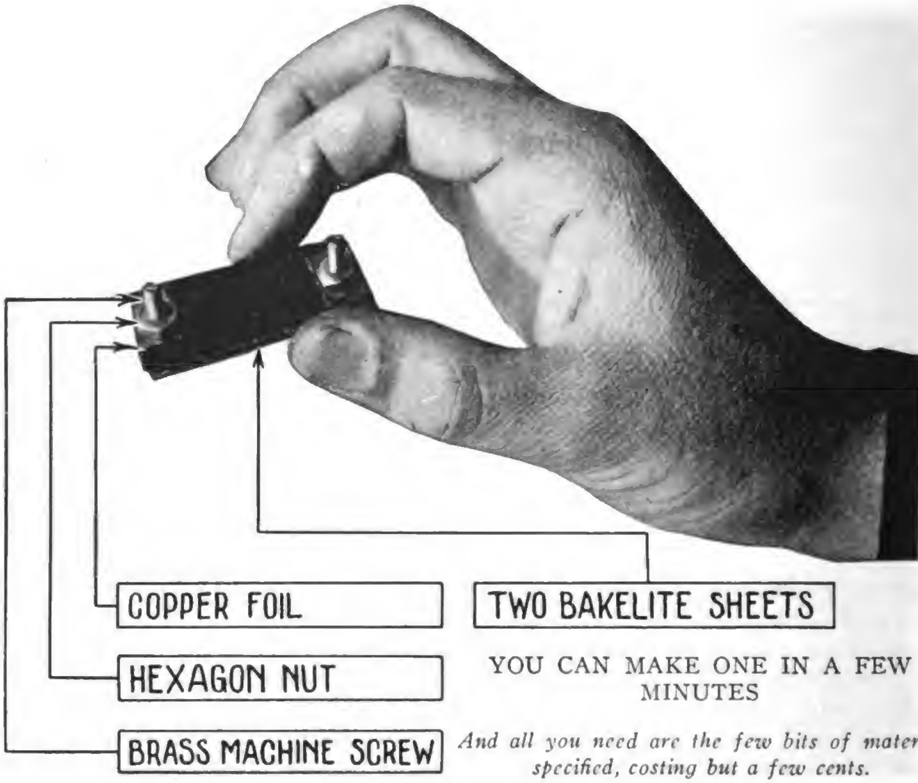


YOU CAN MAKE ONE IN A FEW MINUTES

And all you need are the few bits of material specified, costing but a few cents.

How *to* Make Your Own Grid Condenser

By RICHARD LORD

ONE of the most important parts of a receiving set—and one that is usually neglected by the amateur who builds his own set—is the grid condenser. The usual practice is to build the rest of the set, the vario coupler and the variometers; mount the rheostats and tube sockets, and then look around for some tinfoil and waxed paper. The tinfoil is usually cut into a couple of square pieces of almost any size that the builder happens to prefer at that instant. A hurry up job is then done in the insulation of the two pieces of tinfoil with a sheet of the waxed paper, and two wires joined to the two plates; the so-called "grid condenser" is then stuck into the set to see how it works. If any signals are heard the builder considers himself lucky. If, on the other hand, nothing at all is heard, he tries again and makes another condenser, hoping for better luck next time.

All the luck or element of chance may be taken out of the process of making a grid condenser by following the directions here given; the builder will then

have a grid condenser that cannot be improved upon even if he were to buy one in a store.

Obtain a strip of thin copper, about three mills thick, and cut two strips 2 inches long and ¼ inch wide. Then get a piece of mica sheet and split it to a thickness of approximately .002 (two one-thousandths) of an inch. Any machine shop will be glad to measure the mica for you with a micrometer and will help you split it to get the right thickness for a small sum.

Cut the sheet to a size of ¾ inch wide by 2 inches long. Then obtain two pieces of sheet bakelite ⅛ inch thick, and cut it into two sheets of the same area as the mica sheet. Next obtain two 8-32 brass machine screws, round headed, and four nuts and washers to fit.

The next job is to assemble the parts properly. Place the sheet of mica between the two sheets of bakelite and bore two holes large enough to pass the two screws so that they fit snugly in the holes.

The holes should be bored through all the sheets at once and should be spaced ¼ inch from each end of the sheets. The mica is then taken out from between the two sheets of bakelite and the two strips of copper are placed one on each side of

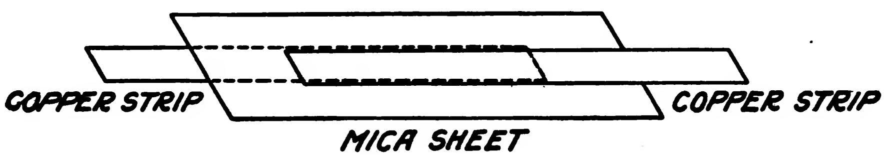


FIGURE 1 (at top)

How the copper sheets should be placed—one sheet on each side of the mica.

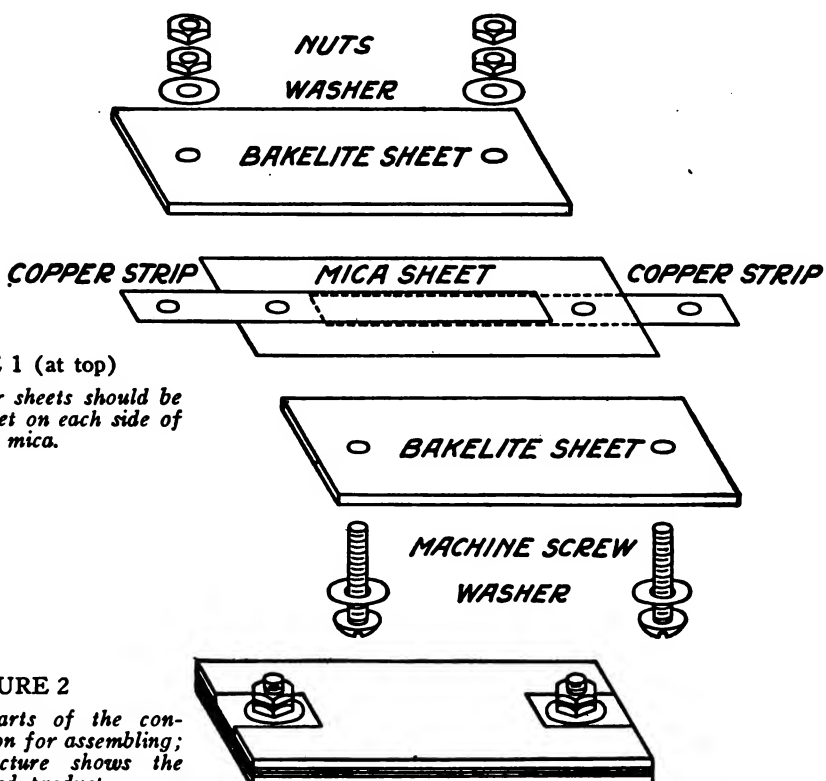


FIGURE 2

The various parts of the condenser in position for assembling; the bottom picture shows the completed product.

the mica. One-half inch of the copper strips sticking out beyond the mica leaves the two sheets of copper overlapping one inch in the middle, but separated by the mica as shown in Figure 1. Place the two sheets of bakelite carefully, one on each side of the other parts and bend the two flaps of copper over on one side, and, while holding them in a clamp, bore the holes so that the screws can be inserted through the whole and the nuts and washers tightened down so that the condenser will be properly held together. In this way the two outside strips of copper make contact with the two screws which act as terminals.

The parts about to be assembled, and the complete condenser are shown in Figure 2.

After the condenser is assembled, fasten two wires, one to each terminal, by screwing down an additional nut on each terminal.

The condenser may be made moisture-proof by immersing it in a bath of melted paraffine. Do not use any solder or soldering flux on the condenser.

DON'TS

DON'T try to transmit without a license.

* *

DON'T forget that tube sets are far more efficient than crystal sets.

* *

DON'T handle the crystals of your set.

* *

DON'T try to get a fine adjustment while touching the detector with bare hands.

* *

DON'T fail to make good connections.

* *

DON'T forget to scrape off the insulation and have wires bright before making connections.

* *

DON'T cover joints with adhesive tape; use "spaghetti' or varnish cambric tubing wherever possible.

* *

DON'T oil any portion of a set.

* *

DON'T blame your set until you are sure it is not your fault that something is wrong.

* *

DON'T be discouraged if the first galena crystal you try is not very sensitive. Try a number of pieces.

DON'T connect the lightning-switch to an inside ground.

* *

DON'T use iron for an aerial.

* *

DON'T forget to keep the aerial and lead-in insulated from all other objects.

* *

DON'T expect to get good results with an aerial less than 100 feet long or low down among other buildings.

* *

DON'T run your aerial parallel with electrical wires, elevated tracks or steel bridges.

* *

DON'T forget that a good ground is necessary.

* *

DON'T try to use your instruments just before, just after, or during a thunder storm.

* *

DON'T rush blindly at the set and turn knobs and handles hit or miss if anything goes wrong. Be calm and patient and go slowly. Haste makes waste in radio as in all things.

An Ingenious "Break-in Key"

A New Time-Saving Device That Enables the Operator at the Transmitting Station To Listen-In On the Receiving Station While He Is Carrying on Communication

By S. R. WINTERS

Harris & Ewing

THE KEY AND ITS INVENTOR

H. E. Hallborg, who is shown above, shares the honor of inventing this practical little time-saver with H. R. Miller—both of the Navy Department.

AN automatic break-key, designed by H. R. Miller and H. E. Hallborg, radio engineers of the Bureau of Engineering, United States Navy Department, greatly simplifies the interception of amplified wireless signals when messages are being transmitted and received aboard sea-going vessels. The radio operator, by the use of this new break-key, can interrupt the progress of a message at any time and ask the sender to repeat a word or sentence without waiting until the entire message has been sent. This interrupting mechanism switches from transmitting to receiving by the use of a novel break-key. The use of a break-key with a crystal detector has been found impractical, and the vacuum tube detector has been even more defiant until the radio engineers of the Navy Department pledged themselves to patient research.

The radio operator's head telephone winding is normally energized by both a constant direct current flowing in the plate circuit and by the signal current pulses of audio frequency. The latter are relatively feeble when produced by distant signal, but exceedingly strong when having their origin in the local transmitter. Hence, solution of the problem resolved itself in a search of means for shunting out of the phones, the heavy artillery of the impulses of local sending, and a removal of the shunting device without affecting the constant plate current of the tube. Achievement of this condition, it was agreed, would make the head telephone immediately responsive for reception.

A low reactance telephone shunting condenser offered a simple and effective solution. The scientific reasoning leading up to this conclusion follows: The normal frequency of a signal is from 500 to 1,000 impulses to the second. A condenser of two microfarads capacity has a reactance of 500 cycles of 159 ohms. The reactance of a pair of head telephones to a like frequency approximates 22,000 ohms. Consequently, the condenser shunt deprives the telephones of 99.3 per-cent of its pulse current and even the powerful radiation of the local transmit-

ter is rendered inaudible. At the same time, the condenser shunt exercises no influence upon the steady plate current of the tube, since a condenser forms an open circuit to direct current. The plate current is, therefore, susceptible to impression by the distant signal voltage at once after the local radiation is cut off and the telephone shunting condenser removed. Decrease in the telephone shunt capacity value permits the radio operator to hear his own sending to any audibility desired.

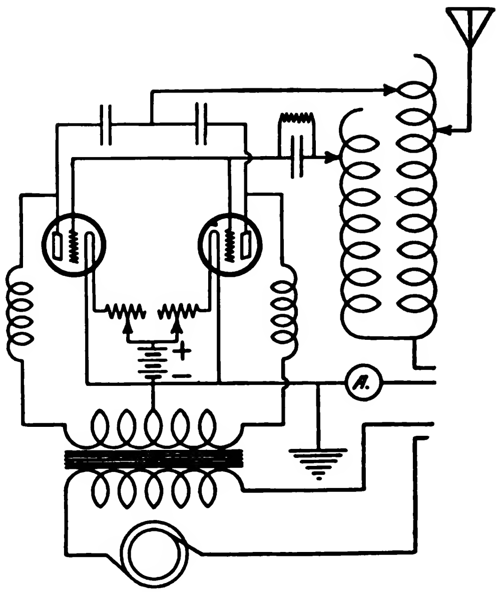
The new break-key involves the use of at least three sets of contacts; a pair to control the transmitting equipment, another pair to shunt the local radiation out of the receiving equipment, and still another pair to shunt the telephones.

This method of breaking in is of practical application and is noiseless and positive even when functioning with amplified radio signals. In actual use the telephone shunting condenser contact is closed first, the receiver contact is next in order, and the antenna contact is last. The contacts are opened in the reverse order.

Breaking in with four stages of audio frequency amplification is feasible with this system. The Hallborg-Miller progeny has been installed on two dozen vessels, and will soon be readily available for commercial use.

The electrical connections of the newly-devised radio interruption system in an alternating current tube transmitter circuit with receiver arranged for two stages of audio frequency amplification are explained in Figure 1. The hand break-key is so constructed as to be fitted with adjustable timing screws. The key is equipped with balance springs, a provision serving to neutralize the inertia of the auxiliary contactors. The operator is thus relieved of undue fatigue when fingering the key.

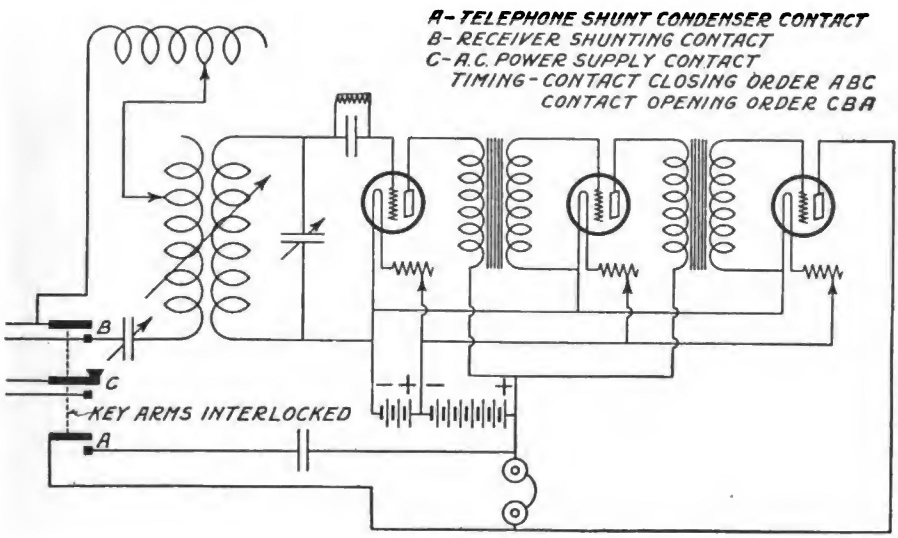
It is not unreasonable to expect that with the universal application of this device to ocean-traveling vessels that radio communication and its traffic burdens



will be handled with the same facility and certainty on the waters as on land. The troublesome task of changing the antenna switch from the sending to the receiving position is no longer necessary.

The break-key has long been a common word with sea-going radio operators, although the prevailing arrangement hardly justified the term. When radiotelegraphy and radio-telephony were popularly represented as an antenna, a sending key, an open spark gap, and the crackling on board ship when a message was in progress, the radio operator clamored for a successful break-key. He was usually recruited from the railroad telegraph station or commercial land-wire telegraph staff, and was picturesquely described as a brass pounder.

His previous experience had made him a master of the simplex, duplex, and quadruplex forms of communication. He complained when compelled to operate a switch necessitating a change from sending to receiving positions a score or more times while clearing traffic of a few hundred words. The "brass pounder" found himself possessed with the insatiable wish to "break" the wireless sending operator when a letter or word or two



THE CIRCUIT USED WITH THE "BREAK KEY"

This is the hook-up employed for connecting an alternating current modulated C. W. transmitter and a two-stage audio frequency amplifier and receiver by means of the special break key. A straight C. W. transmitter and a regenerative receiver may be similarly connected.

was brought into question as to its correct reception.

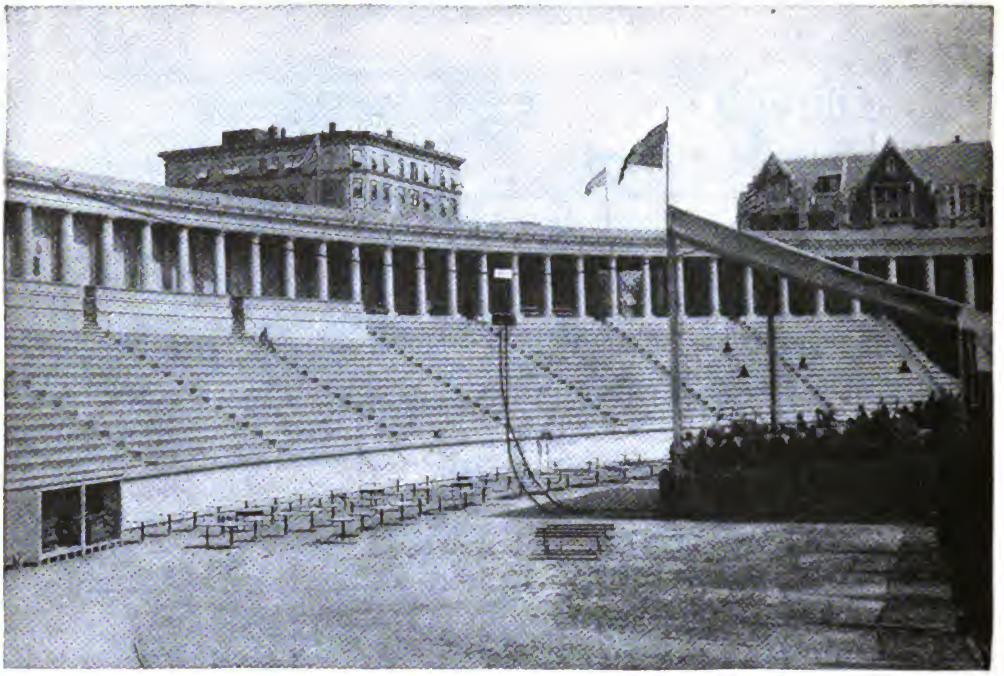
The multiplied troubles of the radio operator on board ship, and persistent complaints to the superintendent, have hurried the development of the break-key. The name was a misfit for the early devices with their multitude of levers, wires and contacts. The delicacy of the equipment was responsible for periodic instruction from the company engineers not to tamper with the outfit.

The "gadget," as it was disrespectfully called, sputtered and flashed at the contacts, and the noises circulating in the telephones further tried the patience of the operator. Messages were received with uncertainty and traffic was frequently congested.

Such is the story of the break-key as applied in the day of the supremacy of the crystal detector. The vacuum tube detector and multi-stage vacuum tube amplifier further aggravated the trouble. The recent invention, however, promises in theory to help the radio operator, whose duties are constantly increasing as the radio art develops.

How *to* Add a Tube *to* Your Crystal Receiving Set

So widespread has become the interest of radio fans in the hand-made crystal receiving set which was developed last spring by the Bureau of Standards in Washington (and described in detail in the May issue of POPULAR RADIO) that a demand has been created for information for improving and developing this apparatus. So Uncle Sam has just produced another set of specifications that tells how to substitute a tube detector for the crystal detector. They will be published with special diagrams and photographs made especially for POPULAR RADIO—in next month's issue.



From a photograph made for POPULAR RADIO

THE EAR OF A MILLION LISTENERS

Suspended twenty-five feet above the ground and about the same distance in front of the concert platform, this microphone (actually only four inches in diameter and four inches long), served to transmit the music over an area estimated at over 2,000,000 square miles.

The Radio Symphony

How the Music of a Great Orchestra Was Played in One State, Broadcast from Another State and Brought Within the Hearing of the People of Half a Continent

ON page 83 of this issue of POPULAR RADIO General Squier writes, in referring to the coming influence of broadcasting upon civilization: "Soon we will be measuring culture by watts."

The General's prophecy had hardly been written when a significant demonstration was made of the possibilities that are rapidly being developed for bringing the world's greatest music to the world's greatest audience—the radio fans of America. For the first time in history the music of one of the greatest of orchestras, the New York Philharmonic, of eighty-five pieces, was transmitted by special wire from the City College Stadium in New York to a distant broadcasting station and sent out by radio to probably the biggest number of auditors that have ever listened in on a musical program. Remarkable as this experiment proved to be in itself, it is still more remarkable in what it presages. No longer is it inconceivable that the world's best music and the world's foremost citizens may literally be brought to the Little Red School House, even in the remote wilderness. Shortly culture may indeed be "measured by watts."

This enterprise was initiated by POPULAR RADIO in accord with its policy not only to serve the interests of the radio fans of this country but also to demonstrate the possibilities of extending radio into larger fields of public usefulness and thus serve the cause of humanity.

THE world's greatest concerts, literally the "greatest" both in the size of the audiences and in the size of the orchestra, were held for five eventful evenings, August 11th, 13th, 14th, 15th and 16th, 1922, at—

At this point the reporter pauses. Ordinarily he would have written "at the City College Stadium in New York." But that would be only a fifteenth or a thirtieth of the truth—possibly only a hundredth of the truth. For while the great New York Philharmonic orchestra (considered by many the best in this country if not in the world) was playing at the Stadium, only an average of 7,000 persons were at that point at one time. Many times that number, just how many is a matter of conjecture, were scattered throughout this country, Canada, Cuba, possibly Mexico, and on ships more than half way across the Atlantic. For these concerts were broadcast from one of the most powerful and most popular broadcasting stations in the world, the famous WJZ, located at Newark, New Jersey.

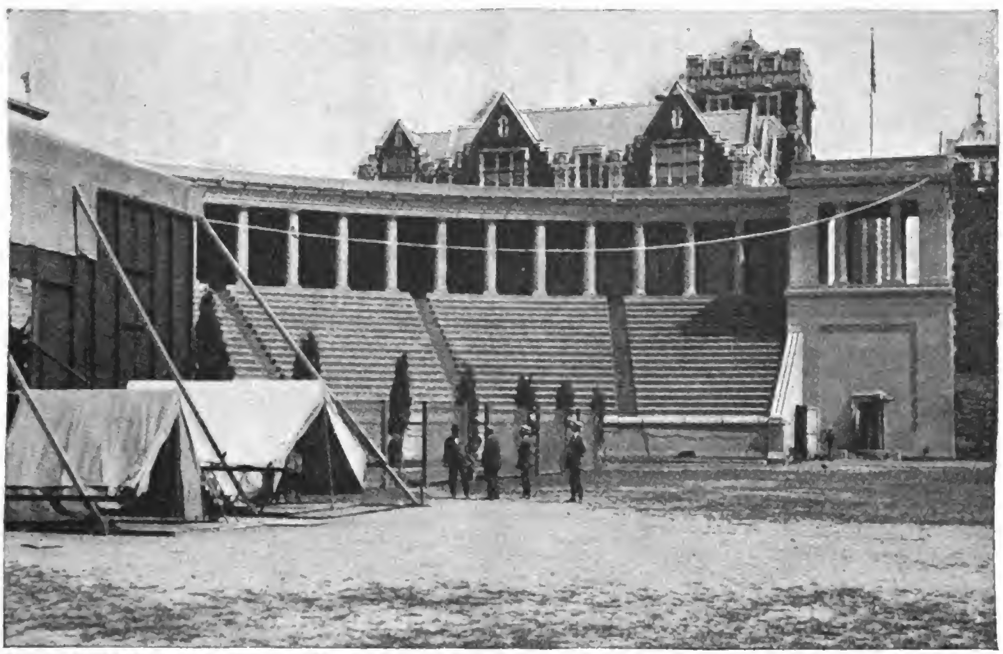
It is no small satisfaction that POPULAR RADIO feels in having initiated this enterprise and made possible a memorable and historical musical treat to the radio fans within an area conservatively estimated at 2,000,000 square miles.

The broadcasting of these concerts marks three notable achievements in the field of both music and radio:

First; it was the first time that the music of a great New York orchestra had ever been broadcast, or indeed the first time that any great symphony orchestra had ever been thus brought within the range of radio amateurs of any considerable part of the country;

Second; it was the first time that any outdoor symphony concert had ever been broadcast;

Third; it was the first time that symphony concerts had ever been transmitted by wire from the concert platform to a distant broadcasting station and sent out in its entirety through space.



From a photograph made for POPULAR RADIO

THE WIRE THAT CARRIED THE MUSIC

From the concert platform, the special telephone wire connected with the Audubon telephone exchange, whence it extended to the broadcasting station in Newark.

The GREATEST AUDIENCE EVER ASSEMBLED AT ONE CONCERT—
The night of August 16th, 1922, will go down as memorable in the history of both radio and of music. On that occasion about 15,000 persons crowded into the Stadium of the College of the City of New York to hear the New York Philharmonic orchestra play a Tchaikowski-Wagner-Liszt program.

Photo by Drucker & Baltes Co., New York

—AND THE GREATEST CONCERT EVER BROADCAST BY RADIO

The music was transmitted by special wire from the concert platform by means of a microphone and sent out from WJZ to an audience estimated at 1,000,000—possibly a hundred times as many persons as appear in this remarkable flashlight, the largest outdoor flashlight ever made.

The plan for this unique undertaking was first proposed to the Stadium Concerts executives (Adolph Lewisohn, the donor of the Stadium in which the concerts were given, Arthur Judson, the manager of the series, and Cromwell Childe) by Kendall Banning, Editor of POPULAR RADIO. These gentlemen promptly seized upon the idea as a means of rendering a public service of a unique character. They realized that even if the Stadium was packed to the doors with standees, it could hold only a little more than 10,000 persons. Only ten thousand could hear at one time the noblest of symphony music, superbly played. But with the aid of radio the same program, with all its cadences, all its tones, all its beauties of musical imagery, might be listened to by tens and possibly hundreds of thousands, sent through space over an area that comprised practically all the country east of the Mississippi River, the eastern part of Canada, and that part of the Atlantic that is included within a radius of 1,500 miles. In other words, the Stadium audiences could be multiplied perhaps fifty-fold.

From a photograph made for POPULAR RADIO

GETTING A LINE ON THE PHILHARMONIC ORCHESTRA

During the outdoor rehearsals on Thursday morning, August 10th, the telephone engineer completed the installation of the special telephone line. On the left is Dr. E. E. Free, and on the right Laurence M. Cockaday, both of the technical staff of POPULAR RADIO.

It was too good an opportunity to be disregarded. The Westinghouse Electric & Manufacturing Company, which operates station WJZ, was consulted; so were the executives of the American Telephone and Telegraph Company. Radio engineers of both companies were called in to study the many technical problems involved. The Westinghouse radio experts agreed with the technical staff of POPULAR RADIO that the experiment would be successful; the experts of the telephone company did not. Eventually, however, a special wire was put in and leased for the period of the concerts and the test was made—with results that are now a matter of radio history.

Radio equipment was installed that made possible the distribution of the Stadium concerts over a territory that represents a population of about 75,000,000 people, operating receiving sets roughly estimated at about 500,000.

The music of the New York Philharmonic orchestra was recorded by a special type of microphone developed by the Westinghouse Company. For the benefit of the uninitiated, it may be explained that this device, in appearance a small black cylinder, 4 inches long and 4 inches

From a photograph made for POPULAR RADIO

THE MEN BEHIND THE RADIO GUNS

At the left is William van Hoogstraten, who conducted the orchestra; in the center is Adolph Lewisohn, who not only gave the Stadium, but served as a patron of the concert series; at the right is Kendall Banning, editor of POPULAR RADIO, *who initiated the broadcasting project.*

in diameter, was suspended in view of the audience about 25 feet in front of the platform and about 25 feet high. It was supplemented by a second microphone located just in front of the orchestra leader's platform for the purpose of recording the soloists. These microphones converted the music (as well as the applause that followed) into an electric current of strength and character that varied in accordance with the character of the sound waves that impinged upon the diaphragm.

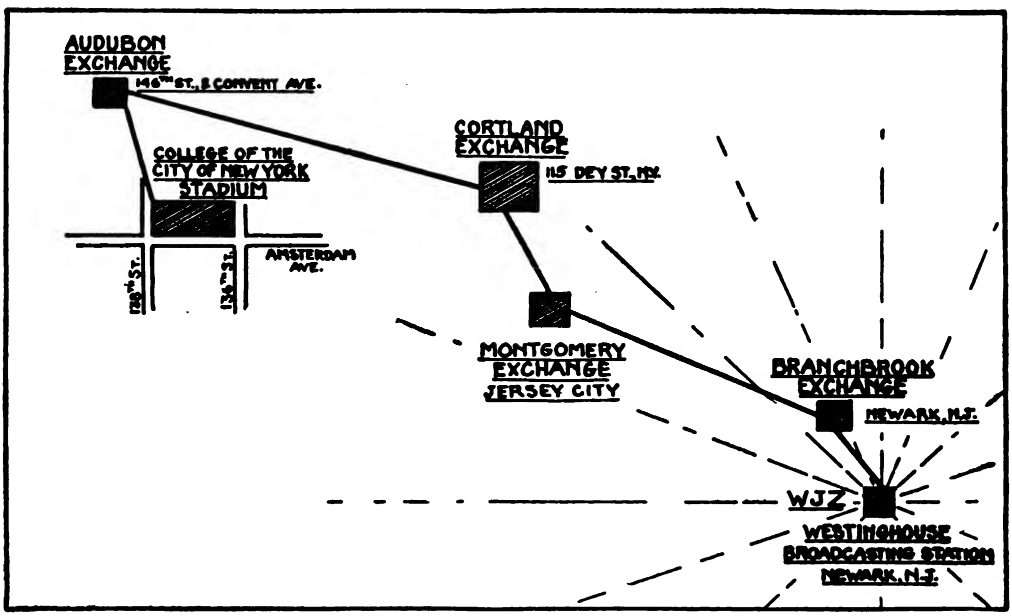
This current was then transmitted over the special wire leased from the telephone company. The wire extended through the various telephone exchanges to the famous broadcasting station WJZ at Newark, New Jersey—a distance of 25 miles from the Stadium. At the broadcasting station the electric current was amplified by means of special vacuum tube circuits; the amplified current was then impressed upon the modulator tubes of the transmitting set. These modulator tubes in turn varied the output of the radio transmitter in accordance with the same sound waves that were impressed upon the microphones at the Stadium. The music thus broadcast could be picked up by any radio receiving set that tuned in to the prescribed wavelength of 360 meters.

How many persons listened in on these concerts will never be known. Some estimates have run over a million. Steamship companies on the seaboard and on the Great Lakes were notified in time to tune in at the prescribed hours and thus permit their passengers to

participate in the event. Hotels did the same. The Astor Hotel in New York, to cite but one example, installed a receiver on its roof and dispensed with its own orchestra entirely on that occasion. Boy scout camps throughout the East tuned in on the advice of their general director, and amateurs generally recorded the experiment with something more than the usual interest, for it was a significant step in the history of broadcasting—and a step taken at a time when the future of broadcasting is still undetermined and fraught with uncertainties. It is perhaps worth more than passing notice that the first number on the first night's program to be heard in its entirety was, aptly enough, the gorgeous Symphonic Poem No. 2 of Saint-Saēns, "Phaeton"—the surname of the mythical sun god Helos, in which all radiant energy has its source.

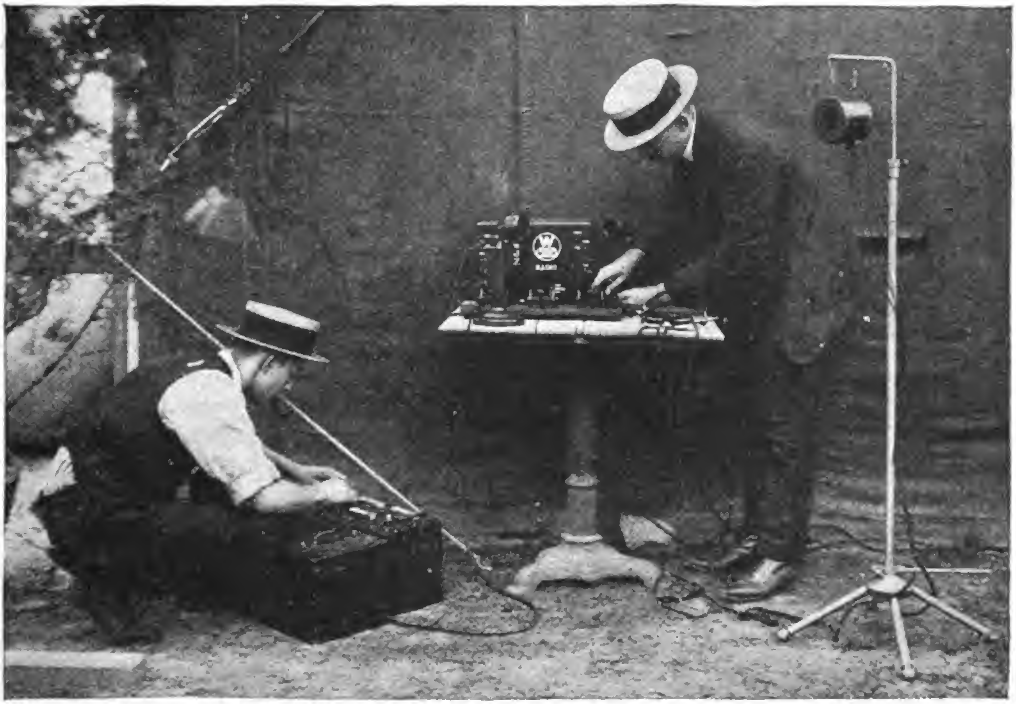
The significance of these concerts was not lost upon the press of the country.

"Cities which have no symphony orchestra of their own cannot hope for an opportunity to hear the greater organizations except at long intervals," observes the Philadelphia *Public Ledger* editorially. "This makes such a procedure as that of the New York Philharmonic the more welcome. Many wireless programs have been of the frivolous, frothy order, with the appetite of the devotees of jazz in mind. Here is an encouraging prospect of better things and an important aid toward an educated public appreciation of the best in music. When Sienkiewicz as a young man visited America he said he could find no music but that of the dance and a few lyric insipidities. There was nothing of Beethoven and the patriarchs—or even of the best of the moderns. How different would be the report if made today! Mechanical agencies of reproduction have vastly extended and intensified the personal effort of the artist. Never in musical history have artists, singly or in groups, had such a chance to be widely heard as they have today."



HOW THE CONCERTS REACHED WJZ

This diagram illustrates how the music was transmitted from the Stadium of the College of the City of New York to Newark—passing through four telephone exchanges (and under the Hudson River) on its historic journey across the State boundary line.



From a photograph made for POPULAR RADIO

INSTALLING THE MICROPHONE AND THE AMPLIFYING APPARATUS

The microphone mounted on the adjustable stand (at the right) was used for recording the soloists; on such occasions the microphone suspended above the orchestra was not employed. The amplifying apparatus was located on the platform during the concerts. It was in charge of Harry Hiller, who is here shown making the preliminary adjustments. The installation was made by William Frazier, the Westinghouse expert on modulation.

The New York *Evening Mail*, always a champion of good music, stated editorially:

"Last night was sent into the air a concert at the Stadium of the City of New York. Over a thousand miles of land and sea the Symphony program rendered by a great orchestra was flashed and perhaps a million people enjoyed its harmonies. They were the people who were prepared to receive it. The notes of the symphony were there for all within the radius of a thousand miles, but only those who had the proper equipment were conscious of them. . . . It may not be beyond the bounds of possibility that man is on the way to the development of the senses that will open up boundless fields of adventure and delight."

For the success of this undertaking the gratitude of the radio fans is due in generous measure to the efforts of Mr. Charles B. Popenoe, who has charge of the WJZ programs and who lent his prompt and enthusiastic help to the project from the first; to Mr. Walter S. Gifford, Vice-President of the American Telegraph and Telephone Company, through whose timely participation the necessary telephone equipment and service was obtained; to the management of the Stadium Concerts; to Dr. W. H. Easton; to the distinguished conductor, Willem van Hoogstraten, to the members of the Philharmonic orchestra, and to the soloists, whose interest in the enterprise did much to make it the notable success that it proved to be. They have the satisfaction of knowing that their concerts were probably heard by a larger audience than ever listened to a concert before in all the history of music.

HINTS FOR AMATEURS

To GET the best results out of your detector tube you should use a variable "B" battery.

* * *

WHEN your set fails to receive, first make sure that you have your antenna "on" and all connections correct and tight and your tubes lit up, before tearing down your set to find the trouble. Sometimes it is some minor fault, such as a loose connection.

* * *

CRYSTAL detectors are easily knocked out of adjustment if some one bumps into the table upon which the radio apparatus rests; sometimes the vibrations of the building, caused by walking across the floor, shakes the apparatus. Many an amateur has been inconvenienced when the crystal has suddenly been thrown out of adjustment, by any one of these causes, in the middle of some interesting communication. This trouble may be reduced if not avoided by standing the receiving cabinet on a sheet of thick felt. The felt takes up the jars that affect the detector and knock it out of adjustment.

* * *

To GET all the fun and enjoyment out of radio, one should by all means obtain a buzzer practice set and learn the code. If a person goes to a foreign country to live, he will not be satisfied to talk to people who speak only his own language, but will also want to be able to understand what other people are saying in the language of the foreign country. If he will devote a small time each day to learning the new language, he will soon be able to speak well enough to make himself understood and to understand what others are saying, so that he will make new friends and get a better understanding of what is going on around him.

Learning the radio code will do the same thing for you and let you "in" on radio as you never would be without this knowledge. Fifteen minutes a day with a friend who is sending to you will accomplish results that you would hardly believe possible. Buy a buzzer practice set; it consists of a buzzer, a telegraph key, and a battery.

* * *

IT IS better to have a separate rheostat for every tube in a receiving set, because you may desire to use different makes of tubes and with only one rheostat for two tubes or more, the tubes may not match up; some will burn too dimly and some too brightly. Even if the same kind of tubes are used throughout, the filament adjustment of all the tubes is not always uniform.

* * *

FOR winding coils to be used for short wavelength reception, ordinary solid copper wire covered with a suitable cotton or silk covering will be found to be just as efficient as the most expensive multistrand wire, such as Litzendracht wire. On the higher wavelengths the multistrand insulated wire will be found to possess a lower high-frequency resistance. This will be found to be true on wavelength about 3000 meters; but below this wavelength the solid wire may be used

with results that compare favorably with the other wire.

* * *

A WAVEMETER is a device for measuring the wavelength of either a signal which is being transmitted from a station or which is being received at the station where it is in use. It consists essentially of an inductance or coil (or a number of coils for different wavelength ranges) across which is connected a variable condenser. When the variable condenser is rotated the capacity of the condenser changes, thus varying the frequency to which the circuit will respond. If we know the frequency to which the different settings of the condenser will correspond, we can easily find out the wavelength that corresponds to that frequency from a table of frequency and wavelength. Most wavemeters have a switch which permits the wavemeter to be used for determining the wavelength of either a transmitted or a received signal.

The use first mentioned is for tuning a transmitting set and the second use is for finding out the wavelength of another station which is sending at the time. A diagram of connections is shown in Figure 1.

* * *

WHEN tne switch is thrown for determining the wavelength of the transmitting apparatus in the station, the wavemeter is really, in effect, a small receiving set without any antenna circuit. A crystal detector is used and when the wavemeter is placed somewhere near the coils of the transmitter, the wavemeter may be tuned by rotating the variable condenser till the signal is heard loudest in the telephones. When this is done, the wavemeter has been tuned to the same wavelength as the transmitter and this wavelength may be read directly off the calibrated scale of the variable condenser, which is calibrated in meters. In this way the operator may be sure that he is sending out signals of a wavelength that it is lawful for him to use.

* * *

WHEN the switch of a wavemeter is thrown for determination of the wavelength of a distant transmitter whose signals are being received, a buzzer is connected into the circuit and the telephones and crystal detector are disconnected. The wavemeter in this state becomes a small transmitting set and the coil of the wavemeter is placed in inductive relation to the coils of the receiving set in the station. The receiver is then tuned in the usual manner to the wavelength of the incoming signal, and then the buzzer in the wavemeter is set into operation by pressing a button on the wavemeter. This starts the miniature transmitter in the wavemeter sending out a feeble wave. The variable condenser in the wavemeter is then rotated until the sound of the buz-

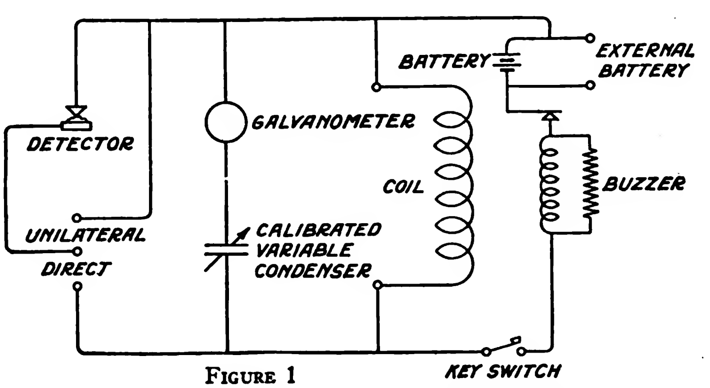


FIGURE 1

A diagram of connections of a wavemeter. When tuning a sending set, the telephones are connected to the two binding posts marked "unilateral"; for receiving, the two posts marked "direct" are used.

zer is heard loudest in the receiving set. When this is done the wavemeter, the receiving set, and the distant transmitting set are all tuned to the same wavelength, and this wavelength may be read off the scale of the wavemeter variable condenser. There is a pointer on the variable condenser which points out the correct reading as the condenser is rotated. A picture of a wavemeter is shown in Figure 2. Note the different-sized coils that may be inserted to get different wavelength ranges. The galvanometer is sometimes used instead of the crystal detector and telephones.

Now you can see how easy it is for the radio inspector to check up on your wavelength. Better watch out that your transmitting wavelength is within the lawful limits!

* * *

WHEN the novice starts to tune a new regenerative receiver he usually gets all kinds of squeals, squawks and grunts—but no signals. It is only natural that he blames the receiver. Sometimes he goes back to the manufacturer and claims that he has been cheated; that the apparatus does not work, did not work and never will work. The set is then tried out by the manufacturer or dealer and found to be satisfactory. The trouble in nine cases out of ten lies with the purchaser; he either does not rig up the set correctly or does not understand how to operate it. Most of the howling noises are caused by turning the regeneration dial around so far that the detector vacuum tube produces oscillations that combine with the incoming signals and start to squeak.

FIGURE 2

A wavemeter. A is the crystal detector, B the galvanometer, C the variable condenser and D the inductance coil.

Learn to operate your set before you pronounce it no good. Ask some friend who understands radio to operate the set, and have him show you how to tune it.

You would not think of purchasing an automobile and starting to drive it home if you did not know how to drive; you would not fool with the levers and switches on the car in the hope that you would pull one or push one that would start the car on the way homeward. Then do not expect to get results from your radio set until you understand at least what the different knobs are for, and have had a little practice tuning in the different wavelengths. "Practice makes perfect" in radio as in everything else.

* * *

YOU can make serviceable binding posts out of 8-32 round head machine screws, a nut to fit, a couple of washers, and a round thumb-nut off the top of a worn out dry battery.

* * *

"HOWLING" in an amplifier can sometimes be stopped or reduced by adjusting the filaments of the vacuum tubes. If this fails, try attaching a wire between the negative terminal of the "A" battery and the ground. Another idea that helps is to ground the iron cores of the amplifying transformers.

HELP *your neighbor. If you have discovered any little Kink that helps to eliminate trouble in your radio apparatus, or if while experimenting with the connections of your set you should run across some interesting phenomenon, or if you should discover some new hook-up that gives better results—send it to the "Listening In" page.*

Who Says "There Are No Ether Waves"?

THE now famous article that appeared in our July issue, "There Are No Ether Waves," with which the distinguished physicist, Dr. Charles P. Steinmetz, stirred up the world of radio, has brought forth a flood of "replies" and inquiries from laymen and scientists alike. Space forbids the publication of more than a small fraction of these communications, but here is a short and pointed one from Louisiana that furnishes food for thought:

I have read with interest the article by Dr. Charles P. Steinmetz in which he calmly brushes aside the consensus of opinion of a dozen great scientists and substitutes for the hypothetical ether of space an even more hypothetical "storage of energy in space," which he does not analyze, explain or apparently admit the possibility of explaining. Men of science the world over will judge whether the great electrical engineer is a greater electrician than philosopher.

Herbert Spencer was the father of the theory of the relative nature of anything cognizable, and Spencer (who was the parent of modern psychology) proved that the brain, as the organ of the mind, had certain well-defined limitations that made impossible a knowledge of anything except the relative. The absolute is unknowable; as Jack London put it, "There is no God but the Unknowable, and Herbert Spencer is His prophet."

Theories and generalizations are dangerous. The circular motion of a fly-wheel is an absolute motion, certainly not a relative one. The onward motion of a projectile, on the other hand, is purely relative to other matter as far as we know. The theory evolved by Spencer and applied to physics by Einstein neither proves nor disproves the "hypothetical ether." The greatest relative motion of stars scarcely exceeds 1,000 miles a second. This fact proves to my mind the soundness of the ether hypothesis. Friction is a property of organized matter, not of a homogenous solid—a fact that Steinmetz ignores in the tenth paragraph of his article. For if matter itself is a mode of motion in the ether, as the mathematical relationship of atomic weights certainly indicates, then there could be no friction between a homogenous solid and a spherocentric vibration in it. (I refer to a spherocentric vibration as the ultimate unit of matter, since only spherocentric vibrations can attract each other in a homogenous medium.) This theory of gravitation is easily proven. Drop two pebbles in a pond of still water; the waves radiate from two oscillating centers. Close observation will show that the centers tend to approach each other.

All the other phenomena of matter depend upon attraction thus explained, upon the radiation of the spherocentric vibrational energy with the gradual decay of matter, and upon "beat" frequencies similar to those of radio but much more rapid. The rapid radiation of energy seemingly makes this theory untenable, but the interaction of a vast number of such spherocentric vibrating points in the ether would tend to inhibit such radiation. That is why gravitation is comparatively such a weak force.

Let's have more articles by the real heavyweights, and Steinmetz certainly is one of them.

JACK ROGERS

* * *

How to Use a Regenerative Set as a Telephone Transmitter

TWO amateurs by accident find out that they can hold two-way communication between their houses by inserting microphones in their ground circuits. This is how they do it:

A friend of mine who is a radio bug lives a distance of about one block from my

Special Press, London

THE HUMAN BODY AS AN ANTENNA

If we were less conscientious we might start out to describe this picture in some such manner as this: "Aerials eliminated through the use of a wonderful new invention"—and then tell how to wrap a few antenna wires around one's body and receive radio signals from Europe. This would give a thrill to the layman and to the novice, and would probably cause a bit of talk at the dinner table. But it would not be the truth. The picture actually shows a man seated in front of a very sensitive receiver that uses radio frequency amplification (five vacuum tubes) with a wire, one end of which is fastened to the antenna terminal of the set, wrapped around his body. The other end of the wire is connected to the ground terminal of the set. The coil thus formed is in reality a horizontal loop antenna, and the set would function if the man were to wriggle out of the loop entirely. The body serves to add only slightly to the distributed capacity of the loop. With any set that employs three or more stages of radio frequency amplification the same results should be obtained. But the novice is warned that this is only an entertaining stunt and is nothing to get excited about.

house. One day I was listening in for amateurs, and I heard a weak voice saying:

"Hello, mother; can you hear me? All right, I'll sing a little song."

With that the voice proceeded to sing "Yankee Doodle." Now Bill has a voice that nobody could mistake and the more I listened the more I was sure it was my friend Bill with a new radio telephone transmitter.

I rushed over to his house and when he opened the door I shouted, "Where is it?"

"Where's what?" he said.

"The new transmitter," I answered. "I heard you."

Then he explained that he had taken an old telephone transmitter and "just for fun" he had connected it in series with the ground wire. Then with the set oscillating, he had spoken into it and was astonished to hear his voice repeated clearly in the telephones which he had on his ears at the time. He induced his mother to listen at the ear pieces while he talked to her. It was at this point that I had caught his voice over at my own house.

After the excitement was over Bill suggested that I get an old unused telephone transmitter and he would listen-in at his house for me, as we both had the same kind of single circuit receivers. I did so, and Bill reported that he heard me very well.

After a week of experimenting with other transmitters and using amplifier tubes and higher voltage "B" batteries we can talk back and forth with our receiving sets. Bill has done four blocks with his set.

ALBERT LANGLY

* * *

How to Restore Worn-Out Crystals

DO your crystals wear out quickly? Often this is because they are dirty. A reader tells how he brings back the

sensitiveness of his crystals. He writes:

I have found that I can bring back the full rectifying qualities of my worn-out and dirty crystals by immersing them in a bath of alcohol for fifteen minutes and then allowing them to dry. The hands should never touch the crystals, as a minute coating of dirt or grease is thus smeared on the surface and an imperfect contact is made by the little adjusting spring.

A. K. BENTON

* * *

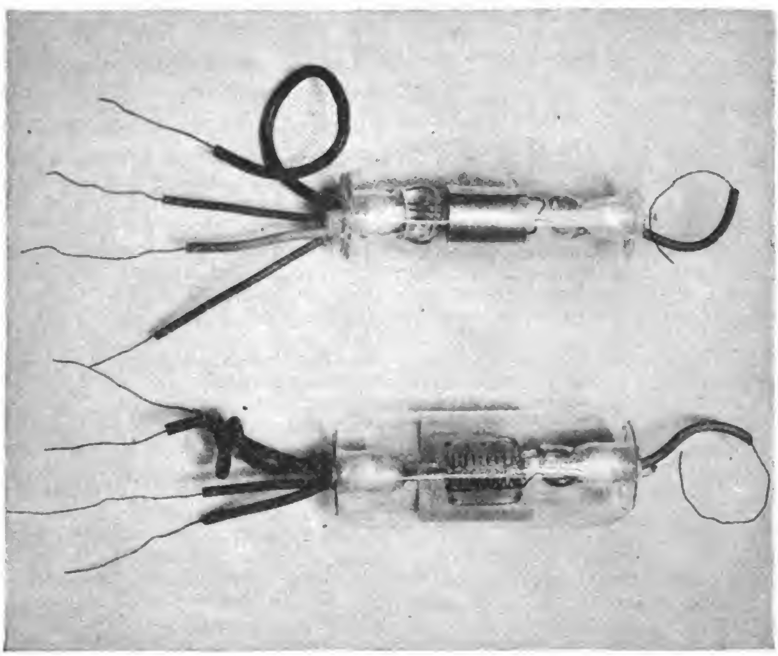
Vacuum Tubes *from* Japan

JAPAN, with her great fleet of merchant vessels as well as war vessels, is keeping abreast of the times with her radio equipment, and following her general policy in other lines, she is "making her own." Here is a letter from a radio operator who recently visited a factory in Tokyo:

On a recent trip through the Far East it was my misfortune to have my one remaining detector tube smashed by a pet ape that had become attached to the expedition as a sort of mascot. My attempts to obtain vacuum tubes had resulted in all sorts of glass-blown objects being submitted by the native merchants in their anxiety to make a few American dollars. An interpreter would listen to the detailed description of the triode and would give assurance that he knew exactly what was wanted and just where it could be obtained; and in a few hours an electric light bulb or a perfume atomizer or a Turkish water pipe—blown glass of every description—would be laid at our feet. At length we were informed by a Japanese radio operator at Yokohama that if we would journey to Toyko we could find what we wanted at the Anaka Wireless Works. So in desperation we started for Toyko.

When we arrived we transferred from the train into rikshas. Considerable trotting up one narrow alley and down the next brought us to the factory. After the necessary diplomatic ceremonies, the manager invited us to inspect the plant. Great was our surprise to see so much highly advanced radio apparatus in process. Complete receiving sets, transmitting sets, motor-generators, radio compasses—everything imaginable in the radio line was there, and most of it was being made by quaint little slant-eyed Japanese factory girls.

At length we were ushered into the vacuum tube department, where we found hundreds of the precious articles being turned out by the same pretty little girls. Their dainty hands deftly mounted the delicate filament wire, adjusted the grid and plate, formed the hot glass; as we watched them several tubes were completed. We marvelled at their



From a photograph made for POPULAR RADIO

VACUUM TUBES WITH A JAPANESE ACCENT

The detector tube at the top is copied from an American model; the amplifier tube below it differs from our tubes in that it uses a second grid instead of a plate.

Kadel & Herbert

STRINGING THE LANDLORD

These young amateurs were forced by their lightning-scared landlord to take down their aerial on the roof. But they obtained a wire-core rope which they strung to the clothes-pole, thus combining the functions of clothes-line and antenna. The landlord has not discovered the subterfuge yet.

speed and accuracy, and were informed by our guide that these girls work on the plan we know as "piece work." We acquired a few of these tubes at a price equivalent to about $2.50 in American money.

Specimens of these tubes are shown in the accompanying illustration. We tried them with good results. One type is constructed with a square glass cage about the filament and grid. Upon this cage is wound a fine wire, about 18 turns; this is the plate. Another type has the conventional sheet metal plate curved about the other elements. Each tube is constructed with two filaments and one extra connection, so that when the first filament burns out the other filament may be used.

These tubes are furnished unmounted, with flexible rubber-covered leads protruding for connection. About 50 volts are required on the plate, and from 4 to 5 volts on the filament, which draws less than ½ ampere. This means that these tubes consume about half as much current from the storage battery as do American tubes. The detectors were found to be sensitive but critical, and the amplifiers not quite as efficient as the Yankee brands.

Radiophone transmission is being taken up seriously by the Japanese navy and army, who have produced several successful designs which are now being used on the ships as well as shore stations. But radiophone broadcasting in Japan has not as yet been started.

E. Jay Quinby

What Would You Have Done?

HERE'S a letter from Fall River, Massachusetts, that raises an interesting problem—which is solved in the present instance with commendable tact:

At the home of a radio amateur in town there were gathered a dozen people who had come to listen to a radio concert. They had been sitting about for an hour and a half, and one by one the broadcasting stations audible at that antenna end were signing off for the night. The operator was twirling the knobs and trying to put up the latter end of as many concerts as he could. Suddenly, there was music—strange distorted music, getting a note in here and there between the instrument's complaints. The operator tuned down and the strains of the "Star Spangled Banner" filled the room. Five people tittered and two laughed outright.

"Do we have to stand?" one of them asked.

"I think we ought to," ventured one.

A moment of discomfort followed, in which no one spoke or moved. Unwilling either to sit or to stand, these people did neither.

"Oh, let's not stand," laughed a listener.

"But we ought to"—the speaker half rose to his feet.

"We'll settle *that* question," said the operator. "We'll not listen to it." And he tuned it out!

Arthur G. Shirt

This department is conducted for the benefit of our readers who want expert help in unravelling the innumerable kinks that puzzle the amateur who installs and operates his own radio apparatus. If the mechanism of your equipment bothers you—if you believe that you are not getting the best results from it—ask THE TECHNICAL EDITOR.

THE flood of inquiries that has poured in upon the Technical Editor has not only furnished evidence of the need of this department; it has also necessitated a system of handling the correspondence that will insure the selection of and answer to only those questions that are of the widest application and that are, consequently, of the greatest value to the greatest number of our readers. Our correspondents are, accordingly, asked to cooperate with us by observing the following requests:

1. Confine each letter of inquiry to one specific subject.
2. Enclose a stamped and self-addressed envelope with your inquiry.
3. Do *not* ask how far your radio set should receive. To answer this inquiry properly involves a far more intimate knowledge of conditions than it is possible to incorporate in your letter.

The questions that are not of sufficient general interest to warrant publication in this department will be answered personally. Many of these questions are being answered by referring the correspondents to items that have already been printed in these pages. To get the full benefit of this service, therefore, *save your copies of* POPULAR RADIO.

QUESTION: I have built the loose-coupled set as described in the July issue. I am not allowed to put up an aerial on top of the building. What other kind could I use? I am about four miles from the broadcasting station. Could this set be changed to a vacuum-tube set?

J. GIVEN

ANSWER: In this emergency you can run insulated wires in back of your picture moulding throughout your house and use it for an antenna. This should enable you to pick up the broadcasting at this short distance. There is no fire hazard in such an indoor antenna. In a near future issue of this magazine we will publish an article telling how to increase the range of the set described, by the addition of a vacuum-tube.

* * *

QUESTION: I have a Clapp-Eastham Type HR Radio receiving set and want to learn the dots and dashes so that I may read the code messages. What is the best way to learn this, and from what concern may I obtain the radio alphabet?

SIDNEY RAND

ANSWER: Consult the article by Paul McGinnis in the July issue, "How to Learn the Code." You may obtain a copy of the code by writing to the radio inspector of your district, or by sending to the office of the Secretary of Commerce for a copy.

* * *

QUESTION: While listening on my radio set, my brother upstairs happened to start tapping on his telegraph instruments that he has connected up on a board. While I could hear the outside sound only faintly, I could hear the ticks in the phones very distinctly. Can you explain this please? Also please give me a hook-up for an audion bulb connected to the set shown in the July issue.

H. STIBBARDS

ANSWER: The phenomenon you describe was caused by induction. The coil magnets in the telegraph sounder sent out feeble magnetic disturbances which were picked up by your set and made audible as clicks in your telephones. An article in a near issue of this magazine will show you how to increase the receiving range of the set described by the addition of a vacuum tube.

QUESTION: Which is the better tuning inductance, the spiderweb coils or the loose coupler?

MILTON DEWITT

ANSWER: Both types of tuners have their advantages and disadvantages, but you probably will get more satisfaction out of the spiderweb coils if used with variable condensers, as this affords an easy and efficient means for tuning.

* * *

QUESTION: I have an audion detector and short wave regenerative set hooked up and composed of standard parts. I have two detector tubes; when I listen I have to put up with a high-tensioned squeal. One tube is as bad as the other, yet when I take the tubes over to a friend's house they work with the best of results. My set works well except for the whistle. In my location I hear WJZ, KDKA, WGY, WGR, 8QB, NOF and many others. Could you tell me what I can do to stop that irritating squeak or whistle? Could it be my ground or aerial system?

S. L.

ANSWER: The trouble is not in your antenna or ground connection; it has entirely to do with your vacuum tube circuit. You are not explicit in describing the symptoms; there are many causes for whistling in a regenerative receiver. Sometimes it is caused by having the regeneration control turned around too far; this causes the tube to oscillate, and the combination of the received frequency and the generated frequency in the tube cause a "hetrodyne" action, thus producing the whistle. Another cause of whistling is the use of excessive filament current. Try turning down the tube rheostats a little. Still another cause is the use of a slightly excessive "B" battery potential on the plate of the tube. Try reducing this voltage a cell at a time and see if this doesn't remedy your trouble.

* * *

QUESTION: I have a small A. C. Thordarson toy transformer having a voltage ranging from 2 to 28 volts in steps of 2. Is it of any use in radio?

ANGEL F. BRUNO

ANSWER: This transformer is of no use in a receiving set, but it might be used in connection with a Tungar rectifying tube for charging your storage batteries. It could be used advantageously in a tube transmitting set for lighting the filaments of the tubes.

QUESTION: Please give me some details on how to construct a loop antenna for listening to broadcasting on 360 meters. What kind of wire shall I use? How much shall I use? Can it be placed on the second floor or the first floor of an ordinary dwelling, or must it be on the roof? How will the results compare with my one wire 100 feet long and 25 feet high outside?

C. L. SIGLER

ANSWER: A loop suitable for use on 360 meters may be made by winding 12 turns of No. 18 copper wire, covered with a single cotton covering, on cross-arms which can be mounted as shown in Figure 6. The length of the arms should be 3½ feet. The turns should be spaced one quarter of an inch. The two ends of the wire are attached to the receiver. The loop may be placed anywhere in the house, close to the receiver. Using two stages of radio frequency amplification you should get the same results as you would with the detector alone on your outdoor antenna. With two stages of radio frequency amplification and two stages of audio frequency amplification you should be able to hear the broadcasting all over the house using a loudspeaker. See Figure 1. The loop antenna is directional in a line of its planes.

* * *

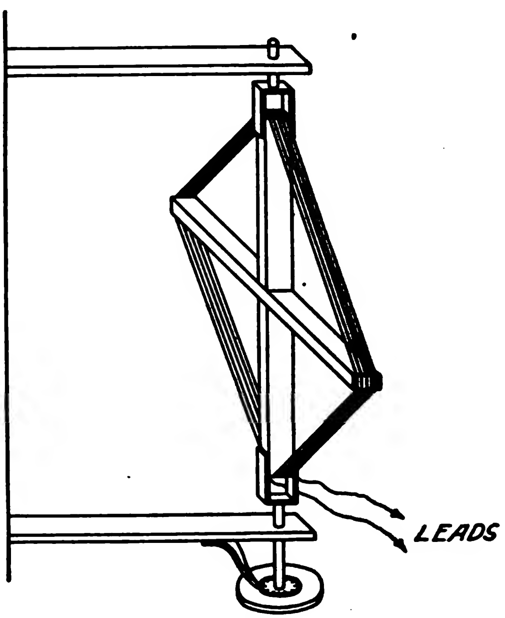


FIGURE 1

A loop connected to a receiving set that is equipped with suitable amplifiers is effective in tuning out directional interference.

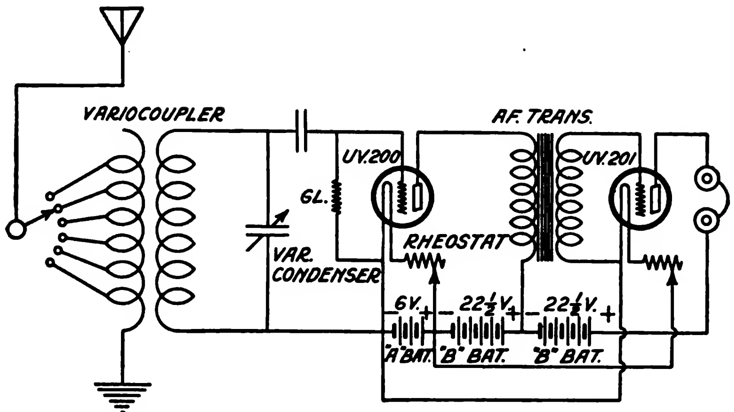


FIGURE 2: *A straight audion circuit with one stage of audio frequency amplification, employing a variocoupler and a variable condenser for tuning.*

QUESTION: I have the following radio parts. Could you give me a hook-up with which I could receive the broadcasting programs?

1 Variable condenser
1 Variocoupler
1 Grid condenser
1 Grid leak
2 22½ volt "B" batteries
1 6-volt storage battery
1 Pair telephones
1 UV-200 tube
1 UV-201 tube
1 Amplifying transformer
2 Tube sockets

LEE TUCKER

ANSWER: Figure 2 will show you how to connect your instruments. You will need two 5-ohm rheostats for controlling the filament current of the tubes.

* * *

QUESTION: I have a radio set which will receive a distance of forty miles, but the nearest broadcasting station is seventy-five miles away. Is there anything that I can do to receive over that distance?

TOM SHORT, JR.

ANSWER: You may add one or two steps of audio frequency amplification to your present receiver; and by doing so you will undoubtedly increase your receiving range up to, if not beyond, the distance that you mention. Such an amplifier was described on page 142 of the June issue of POPULAR RADIO, and diagrams and photographs of the apparatus will also be found on the same page.

* * *

QUESTION: I am going to get a government amateur license and am wondering what kind of a transmitter to install. I had two kinds picked out which were within my means; one was a spark set and the other was C.W. My aerial would be about fifty feet high and of the cage type; my spark transmitter would be a two-inch coil with an open gap and helix. My C.W. transmitter would use an amplifier vacuum tube with 112 volts on the plate. Of course I would use it for telegraphy only. Which one would you advise me to install, not figuring on cost or up-keep? Which one would send the farthest for telegraphy?

ASHLEY C. DIXON, JR.

ANSWER: We would advise you without reservation to install the C.W. transmitter, as it is the most modern and the most efficient. In the August issue of POPULAR RADIO, on page 294, is a hook-up of a one-tube transmitter which would be suitable for you to use. Of course you may use the UV-201 tube instead of the larger 5-watt tube recommended. In this case you would not use the motor-generator as shown but you could substitute 110 volts from a "B" battery or else use the 110 volts A.C. house lighting current for telegraphy. The C.W. set will send much farther than the spark coil.

Other advantages of the C.W. set include quiet operation—without the noisy spark displays; sharply-tuned emitted wave, with small interference, and compactness.

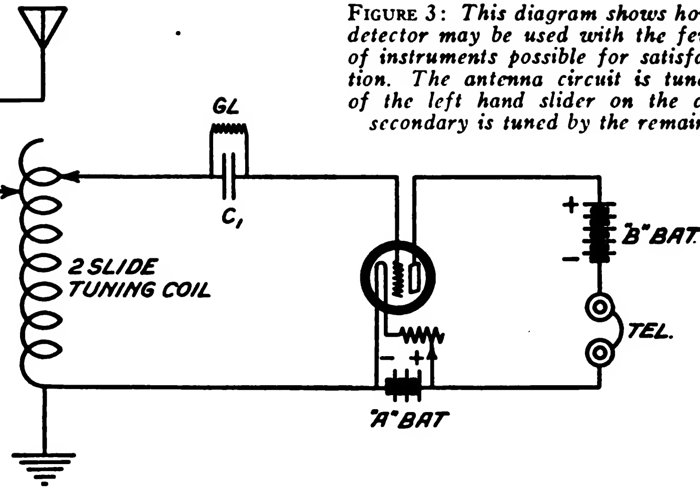


FIGURE 3: *This diagram shows how the audion detector may be used with the fewest number of instruments possible for satisfactory operation. The antenna circuit is tuned by means of the left hand slider on the coil, and the secondary is tuned by the remaining slider.*

QUESTION: How would a two-slide tuning coil be connected to the vacuum tube set described by A. Hyatt Verrill in the June issue of POPULAR RADIO? Please illustrate by a diagram.

BURNETT COOK

ANSWER: The tuning coil should be connected as shown in Figure 3. No variable condenser is necessary when this type of coil is used.

* * *

QUESTION: Will you kindly show me a hook-up of an installation of a lightning ground switch?

THOMAS HEDGES

ANSWER: The connections for the installation of the lightning switch are shown in Figure 4.

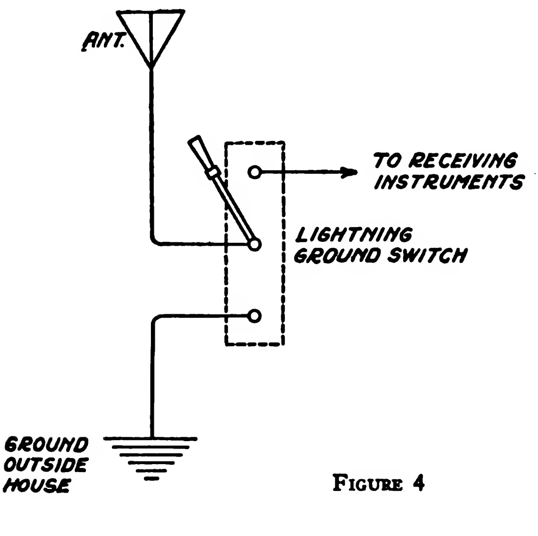


FIGURE 4

QUESTION: Please give a hook-up for a C.W. telegraph and telephone transmitter using one 5-watt tube and "B" batteries on the plate.

ORVIL WILSON

ANSWER: On page 294 of the August issue of POPULAR RADIO you will find a circuit for a 5-watt transmitter. You may substitute the "B" batteries for the motor-generator, in which case you may eliminate the filter circuit. This circuit is suitable for your needs.

* * *

QUESTION: Will it make any difference to my set if I join the ends of my aerial? Can you show me how to wind a honeycomb coil?

HAYWARD HEWSON

ANSWER: It will help in transmitting slightly if you make the proposed change. We would not advise you making your own honeycomb coils, as they can be bought at less expense than the time expended on making would be worth. The home-made coil would not be as efficient.

* * *

QUESTION: Has an antenna 35 feet high much advantage over one 25 feet high for receiving? Is it advisable to have antenna wire and lead-in wire in one piece?

ANONYMOUS

ANSWER: The effective height of the antenna would be increased, therefore the antenna would be more efficient. If the antenna wire and the lead-in wire are not one piece, they should be soldered. When soldered connection is made between the two pieces they will be as suitable as one continuous length.

WHAT *is the biggest thrill YOU ever got over the radio? Have you ever picked up a call for help? Or located a lost friend—or helped to run down a fugitive, or listened in on a conversation of peculiar personal interest to yourself? For every anecdote, humorous or grave, ranging from 50 to 300 words in length, the Editor will pay upon acceptance. Address contributions to the Editor,* ADVENTURE IN THE AIR DEPARTMENT, *9 East 40th Street, New York City.*

I Share the Thrill That Comes But Once in a Lifetime

OUT of the wilds of northern Canada comes this true story that carries with it something of the ring of triumph that we associate with tales of struggles of the heroes of old—only in this case the heroes are eminently modern and characteristically American:

It was the night of the trans-Atlantic tests, December 11th, 1921, to be exact, when (as all the world now knows) the members of the American Radio Relay League were trying to push their 200 meter signals over to England.

I was back in the heart of the bush in the northland of Canada on this particular evening. I had difficulty in keeping the shack warm, owing to a snuffling 30-below wind which found every unplugged crevice in the rough building. The day had been a hard one—most days usually are back here—and for an hour I had been listening to the "free for all" gang of amateurs. Some of their transmitters wheezed asthmatically, some trumpeted sonorously, and other C. W. signals came like the moaning of lost souls. After them came those amateurs who had qualified for special schedule tests by successfully transmitting over 1,000 miles overland in the preliminary tests.

It thrilled me to realize that I was listening to the cream of American amateurs, endeavoring with their pet equipment to fling the paltry energy of a few dry cells across the ocean wastes to throbbing England. Paul F. Godley was over there—somewhere—listening. As I slowly moved the variometers I would hear 3DH of Princeton studiously sending his cipher and call letters, followed by IARY, who would valiantly swing in, reminding me of soldiers snatching the swords from the hands of fallen comrades.

It was close to 1:00 A. M. and I still sat listening to the boys pleading across the dark Atlantic for a hearing—broken only by outside sounds of wolves howling faintly and the creak of moosehide thongs as my dogs outdoors grew anxious for battle. I had been looking forward to these tests for months and had the receiver tuned to a hair. Indeed I had twice mushed fourteen miles to the Post Office through a blizzard and bad drifts for a spare bulb which never arrived.

And now the time so much anticipated was here. Would we fail to get across to-night? We fell down last night. I will never forget the miserable pang, when, after a three hours' vigil checking up the strength of various stations' signals and speculating as to who would or should get across, I heard the monotone chant from MUU:

"No signals heard."

Was the task of getting through on 200 meters to Europe impossible? Some of the cleverest men in the radio world had said it was.

Thus the minutes slipped on, my mind first going over the fizzle we made of the last attempt during the early part of the year, wavering with doubt over last night's "No signals heard" from Godley, only to be eventually buoyed up by new hope which fed on dying hope.

During the tests I had removed the aerial and ground from the set, and still some of the boys pounded through to me—here in an Arctic world—on the edge of everything!

It was 1.59 A. M. I snapped in the honeycomb coils on the long wave set, threw the aerial switch over to the 300 foot single wire, and began sliding the condensers over for Paul's message from MUU at 2 A. M. On my way up I passed the Old Reliables, NDD the fiddler, NPM the hand-bell ringer, and WSO the blacksmith. I was busy juggling out WII and WGG (scratching a clean, quiet spot for MUU) when—I heard the sweetest music that ever passed across a vacuum tube. It came

like a vesper to a tired soul at eventide, over the seas from Canarvon, Wales—over a hundred blazing cities and leagues of darkened unmapped forests—right into this little shack here, nestling in the curving snowbanks of a white wilderness, telling me that Godley had "heard amateur signals from America in Scotland!"

Did I hear aright? Had I fallen asleep and just dreamed this thing? With dropped jaw I heard WII repeat Godley's message to our headquarters at Hartford, Conn.

A surge of emotion swept over me as I removed the receivers and dropped my head on my arms.

It had been done.

An American amateur, crouched on Scotland's bleak coast in the chattering misery of an icy, slanting rain, had accomplished a feat which has placed puckers of new thought on the broad brows of those eminent scientists who had smiled behind their hands. The American amateurs had achieved the "impossible."

M. J. Caveney

I Help Save a Child's Life

NOT often does a radio operator get the coveted opportunity to render service as came to the New Orleans fan who sends in this adventure:

I was stationed on a lonely island as radio operator for a prominent radio company. The only other means of communication with the cities was an uncertain and slow mail service by boat twice weekly when the weather permitted. I was alone at the station and so had certain schedule hours for working during the day and night. During the summer a few visitors came to the island for the bathing, and they used the radio service more or less to keep in touch with home matters.

One day there came to the island a prominent man with his wife and their little girl. The child was taken violently ill during the night. The distracted parents were at a loss as to what to do until the father came to the station, waked me and asked to get in touch the family physician in a nearby city.

I started my engine, got the station I wanted and asked the operator to get the physician on the telephone and have him hold the wire. He inquired how the charges were to be handled and I told him to keep a record of everything sent and received, also the telephone charges if any, and that my party guaranteed everything. There was no delay in getting the physician on the wire. I gave him the name of the party and described the symptoms; the physician in turn asked questions which were repeated to me, and I relayed the answers back to him. He then prescribed treatment and asked that we call him again in a few hours to let him know if the patient was relieved.

In a short time the father was back at the station and asked me to get the connection again and advise the physician that the pains were gone and the child was sleeping quietly; this was done and the doctor advised an immediate return to the city. Before leaving the next day both father and mother came to the station and were profuse in their thanks for the radio service.

This was the first time I had seen radio used in such manner and it made a deep impression on me. Without the radio service it would have been impossible to get medical advice promptly. It is probable that the radio saved the little patient's life.

George F. Patrick

I Unfathom a Strange Phenomenon in the Head Phone

ONCE upon a time some college students carefully attached the wings of one kind of bug upon the body of another insect and submitted the result to their professor for classification. "This," announced the old gentleman gravely, "is a humbug." Possibly the second operator mentioned below was a student in the same class:

I relieved Bert Lane, the second operator, at six o'clock in the evening as usual. I picked up the magazine I had discarded when relieved from my morning watch, arranged the phones comfortably and lit my pipe. I noticed that Bert cleared out rather promptly.

Shortly after, I noticed a peculiar hum in the phones, accompanied by a scratching sound foreign to anything I had ever heard before. This came on at intervals for the first fifteen minutes or so of my watch. I put the occurrence down as a new brand of induction from the chief's ancient dynamo and didn't think much about it. Suddenly I became conscious that it was audible in one phone only, yet Cape Race was pounding away with a fine quality of sending in both receivers.

What was the cause of this strange phenomenon?

I became suspicious. I removed the phones, unscrewed the ear cap of the defaulting one, slid off the diaphragm . . . and out crawled a common fly.

How did it get there? Maybe Lane could tell.

T. C. Van Alstyne

¶ *Are you thinking of taking up radio as a livelihood? Do you want to become a radio operator? Or a radio engineer? Do you want to know how, where the positions are and how to fit yourself for them?* Popular Radio *will shortly begin a series of articles by practical radio experts that will tell you the real facts.*

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BY PLACING one stage of Tuned Radio Frequency Amplification before the detector tube, we not only amplify the signals before they reach the detector, enabling it to work more efficiently, but also make sharper tuning possible and eliminate interference and static to a wonderful degree. These sets are especially designed for broadcast reception, covering a range of from 200 to 600 meters and we believe they cannot be equaled at any price.

CROSLEY RECEIVER MODEL X. Is the same as MODEL VI with two stages of Audio Frequency Amplification added. In placing this receiver on the market we are offering you a unit whose range, volume and selectivity is remarkable. Nothing can compare with it at twice the price. Developed in the CROSLEY laboratories, this unit is absolutely the last word in long-range Radio Receiving Apparatus. Used with head phones and loud speaker, it will bring in distant stations all over the house Price, without phones, batteries or tubes, **$55.00.**

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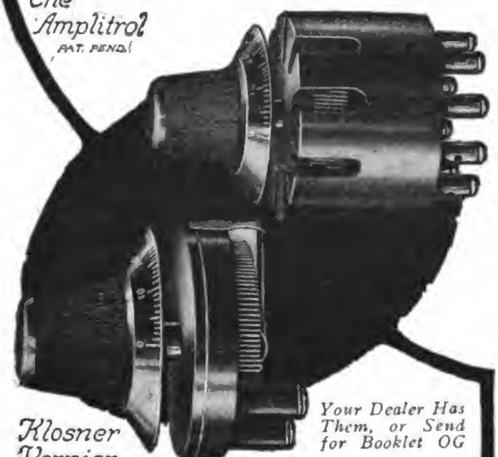

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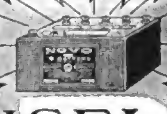

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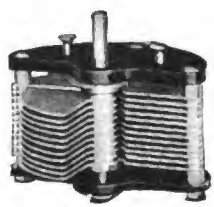

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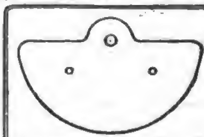

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All Radio Sets installed FREE in the homes of the winners anywhere in the U. S. A.

1st Prize

This cabinet type complete Radio Receiving Set is one of the finest and most up-to-date sets on the market. It is designed and manufactured by the Colin B. Kennedy Company of San Francisco and St. Louis, makers of the finest type of radio receiving sets. The cabinet is walnut and stands 58 inches high—a masterpiece of cabinet making. The receiving set is regenerative, having an effective range from 175 to 25,000 meters—400 to 600 miles on "broadcasting." Contained within the cabinet are all batteries, Magnavox Loud Speaker with special horn, "Homcharger" Battery Charger. Value complete, $725.00.

2nd Prize

It consists of the Westinghouse R. C. Receiving Set, Western Electric Loud Speaker, "Tungar" Battery Charger, Storage Battery, 9 "B" Batteries, one Manhattan 3,000 ohm Headset, 3 vacuum tubes, 2 telephone plugs, and complete antenna equipment—a total value of $408.50.

3rd Prize

A complete receiving outfit made up of the well known Grebe CR-9 Regenerative Receiver with 2 stage amplifier, Magnavox Loud Speaker, Storage Battery, "Homcharger" Battery Charger, "B" Batteries, one Manhattan 2,000 ohm Headset, 3 vacuum tubes, 2 telephone plugs, and complete antenna equipment—a total value of $256.50.

50 Other Prizes

To 50 other contestants, whose answers the judges decide are most meritorious, will be given one of the famous Manhattan 2,000 ohm Radio Headsets. These headsets are built with the precision of a watch and have great sensitiveness and high amplifying qualities.

Win this $725.00 Radio Set FREE

Only a rich man could buy it but a poor man may win it FREE

SIMPLY obtain a free "Red Seal Battery" contest blank between November 1st and November 15th from stores that show the Window Display pictured below. Each contest blank gives full simple instructions to help you write your answer and full rules of the Contest.

Red Seal Battery Finish-the-Sentence Contest

The prizes will be awarded for the most appropriate answers for completeing *in your own way* in not more than ten words, the following sentence:

"The Red Seal Dry Battery is best
(1) because it is the all-purpose battery and
(2) because........................

Examples

Your answer may be descriptive of the Red Seal Dry Battery or it may describe some use. For example: "It never fails on land, air or sea." Another: "It never starts what it can't finish." Another: "It rings bells and buzzes buzzers."

Judges

The judges of the Contest are: Mr. Llew Soule, Editor of *Hardware Age*, New York; Mr. Howard A. Lewis, Manager of *Electrical Merchandising*, New York, and Mr. Joseph A. Richards, President, Joseph Richards Co., Inc., Advertising Agents, New York.

Awarding the Prizes

Prizes will be awarded to those who conform to the rules of the Contest and whose answers, in the opinion of the judges, are most appropriate. In case two or more persons submit winning answers, prizes identical in character with those offered will be given to each successful contestant.

Announcing the Winners

As soon as possible after the judges have rendered their decision the names of the prize winning contestants will be announced in the *Saturday Evening Post.*

Look for this Window Display n Dealers' Windows Nov. 1 to 15. It identifies all stores that have free contest blanks.

Contest Opens Nov. 1—Closes Midnight Nov. 15.

All answers must be written *only on contest blanks* supplied by dealers displaying Red Seal Battery Contest window display. Send as many answers as you like to:

Red Seal Battery Contest
Manhattan Electrical Supply Co., Inc.
17 Park Place
New York City, N. Y.

MANHATTAN
ELECTRICAL SUPPLY CO., INC. NEW YORK

Makers of the Famous Red Seal Dry Batteries and Manhattan Head Sets

"As good as Brandes"

ONLY if a headset bears the name Brandes can it be "as good as Brandes." And genuine Brandes *Matched Tone* headsets cost no more than less sensitive and less rugged imitations.

Send ten cents in stamps for the "Beginner's Book of Radio," which explains radio in terms that anyone can understand.

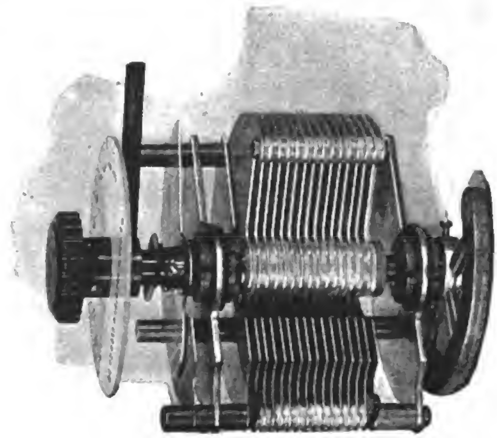
Distributors and District Offices:
Munsey Bldg., Washington, D. C.
76 Pearl St., Boston, Mass.
33 S. Clinton St., Chicago, Ill.
709 Mission St., San Francisco, Cal.
International Electric Company.
Wellington, N. Z.

C. Brandes, Inc.

Matched Tone Headsets
237 Lafayette St., New York

Made in Canada by Canadian Brandes, Ltd., Toronto and distributed by Perkins Electric Ltd., Montreal

Result of 14 Years Experience



Thanks for Your Patience!

THE radio public was very patient when we were unable to supply De Forest Vernier Condensers, because they knew that all we could make were going into the famous De Forest MR-6 Receiving Sets.

Now, however, you can have the satisfaction of putting genuine De Forest Condensers on that special set you are building. The CV-1003 and CV-1503 Vernier Condensers are now again available. Production has been increased as fast as was possible—always remembering the maintenance of De Forest quality.

It is only necessary to remind you of some of the reasons why these Condensers have been declared perfection by radio experts. The movable plates are heavier than those in any other. The separately controlled Vernier plate gets you "in on the peak" and gives you 20% louder signals. The securely fastened counter weight acts as a balance and permits smooth, accurate operation in any position. Each Condenser is individually tested at 500 volts. The whole construction is a fine example of scientific precision laboratory equipment.

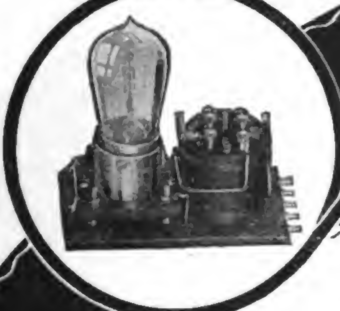
Used with De Forest Honeycomb Duo-Lateral Coils, these Condensers provide tuning equipment unsurpassed for selectivity, sharpness, and all-round efficiency.

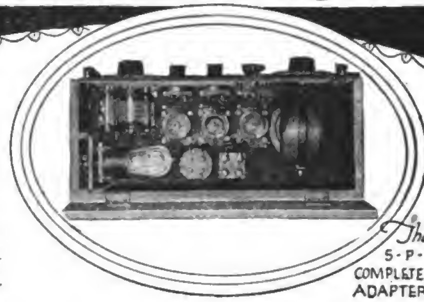
De Forest Radio Tel. & Tel. Co.

Jersey City, N. J.

DE FOREST

And now the S-P-2 "ADAPTER"





The S-P-2 COMPLETE with ADAPTER

Another remarkable feature added to the amazing S-P-2 Receiver. An Adapter representing an additional stage of audio frequency amplification, added to the S-P-2 Receiver AS SIMPLY AS INSERTING A TUBE INTO A SOCKET. Without necessitating the change of a single binding post, wire or batteries or headphones! The S-P-2 Adapter is a basic patent and is thoroughly covered.

The S-P-2 RECEIVER, now in vast production and under the severe test of hundreds of dealers everywhere, has thoroughly established its claim of ACTUAL SUPERIORITY as against any regenerative receiver now offered costing $125 to $180, based on actual comparisons. THE LIST PRICE OF THE S-P-2 IS BUT $85, WITH AN ADDITIONAL CHARGE OF $15 FOR THE ADAPTER.

The S-P-2 is a complete Receiver of radio-telephone and radio-telegraph signals over a wavelength range of from 180 to 650 meters, using three tubes, viz.: detector, one stage of radio frequency amplification and one stage of audio frequency amplification.

In emphasizing REMARKABLE REFINEMENT, we claim for the S-P-2 a TONE QUALITY of distinct class.

It brings the QUALITY in music and in all instrumental and vocal signals that is now universally desired and demanded, practically eliminating all atmospheric disturbance and "noise."

In thorough tests, using a single wire antenna 40 feet long and approximately 20 feet above ground, the entire broadcasting programs of Newark, N. J.; Schenectady, N. Y.; Davenport, Iowa; Louisville, Ky.; Atlanta, Ga.; Detroit, Mich., and Kansas City, were received nightly in Pittsburgh, Pa.—and during the midsummer, supposedly poor receiving months. This reception was duplicated when using four wires strung along the ceiling of a one-story building. In the most severe tests, interference from static was not noticeable.

DEALERS:
Write for Catalog 101A

PITTSBURGH RADIO SUPPLY HOUSE

963 Liberty Ave. Pittsburgh, Pa.

BELL TELEPHONE
GRANT 3632

This Coupon

And a dollar bill will bring POPULAR·RADIO to any address in the United States or Canada for the next 8 months. This is a trial subscription offer.

By using this coupon you will save yourself money. The regular yearly rate is $1.50. This special $1.00 rate for 8 months is for new subscriptions only.

COUPON GOOD UNTIL NOVEMBER 1, 1922

POPULAR RADIO, 9 East 40th Street, New York City Date.......................

Enclosed please find $1.00 for which send me an eight months' trial subscription in accordance with your special offer. *(Please write your name plainly)*

NAME..

ADDRESS...

....

....

THE "NORTH STAR" RECEIVER

Type 1-GR

(Regenerative)

Designed and developed by experienced Radio Engineers for those who demand modern radio apparatus of high efficiency and scientific construction. This Type 1-GR Receiver is the best to be had. Our method of assembling the various units assures perfection in operation. The cabinet is made of hand-polished walnut. The panel and dials are of the very best grade of bakelite. The variometers and vario-coupler are Atwater-Kent. All connections to the set are made through the rear of the cabinet thus concealing all unsightly wiring. The wave length is 150 to 650 meters. Regeneration is perfect on all wave lengths.

At our Minneapolis, Minnesota, station, with a 70-foot two-wire antenna, we are able to hear wireless 'phone concerts sent out by the following stations, plainly and distinctly:

Atlanta, Georgia.	Kansas City, Missouri.
Detroit, Michigan.	Denver, Colorado.
Pittsburgh, Pa.	Cincinnati, Ohio.

Schenectady, N. Y.

PRICE, WITHOUT TUBE, PHONES OR BATTERIES:

$57.50

PRICE, COMPLETE WITH EQUIPMENT AS FOLLOWS, READY TO INSTALL:

1 Raditron UV 200 Tube. 1 Novo "B" Battery. 1 Aerial. 1 pair 2000 ohm Frost Phones. 1 80 ampere Grand Storage Battery. 1 Brach lightning protector. Complete instructions.

$78.50

THE "NORTH STAR" TWO STAGE AMPLIFIER

Type 2-GA

Designed and developed to match the above Type 1-GR Receiver. By means of this amplifier and the above Receiver, all of the larger broadcasting stations in the United States are heard at our Minneapolis, Minnesota, station with sufficient volume for use with a Type R-3 Magnavox. With this outfit, concerts broadcast from Atlanta Journal, Atlanta, Ga.; Detroit News, Detroit, Mich.; and the Sweeney School, Kansas City, Mo., are heard plainly and distinctly throughout the entire building.

PRICE, WITHOUT TUBES OR BATTERIES:

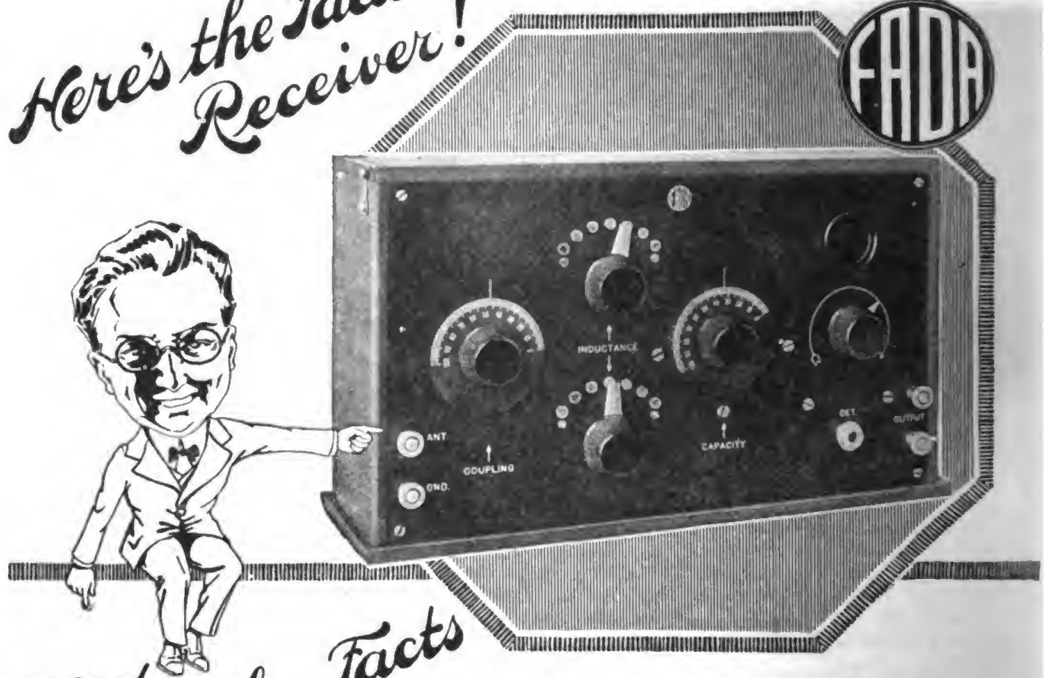
$50.00

DEALERS: WRITE OR WIRE FOR SAMPLES.	WE CAN OFFER YOU ATTRACTIVE DISCOUNTS, MAKE IMMEDIATE DELIVERIES, GIVE YOU EXCLUSIVE TERRITORY, AND FURNISH YOU WITH AN INSTRUMENT THAT WILL BOTH SELL AND SATISFY.

MINNESOTA RADIO SALES CORPORATION

512 Palace Building **Minneapolis, Minnesota, U. S. A.**

Here's the Fada Receiver!



and There's the Facts about it · An Ideal Home Entertainer

The Fada receiver, a result of the same perfection in design and construction that distinguishes all Fada products, is gaining popularity as an ideal home entertainer.

When it's radio time in your home, you can sit back in your favorite chair, among the family circle, and command at your fingers' touch the talent of such noted artists as May Peterson, Percy Grainger, Mme. Margaret Namara, or Lydia Lipkowska—Russian coloratura soprano of the Imperial Opera of Petrograd.

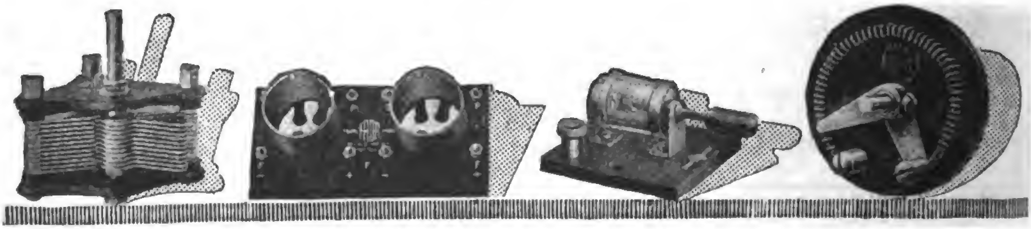
You marvel that voices can come into your home with such depth of emotion and true personality. Music is an inspiration to everyone, it goes to the very soul of things and brings joy and happiness to all.

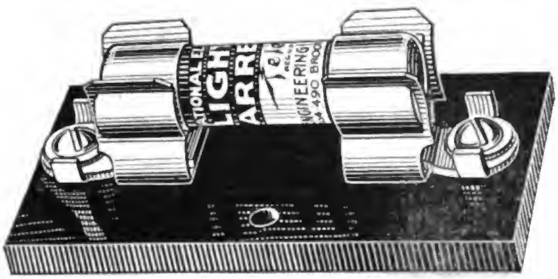
With a FADA radio receiver music can be made part of your daily re-creation. And after the musical program there is broadcasted a digest of important world events. You can, with a FADA receiver, literally keep a jump ahead of the headlines in tomorrow's newspaper.

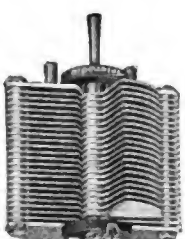
THE FADA HANDBOOK of FADA–FACTS

The new FADA handbook will be sent to you upon receipt of 5c to cover postage. It's a How-To-Do-It book and you should have it

FRANK A. D. ANDREA
1581-D Jerome Avenue, New York City







CHARLES FRANCIS PRESS, NEW YORK

Endorsed by Paderewski!

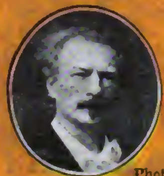


Photo by Paul Thompson

It was with great pleasure that I heard your Bel Canto loud speaker, the other day. The clarity and volume of tone transmitted, and particularly the absence of sound distortion make it a remarkable device.

While listening to different radio stations, some of them far away, I heard music and lectures with surprising distinctness, and the reproduction of Victor records sounded to me as if the performance were taking place in the same room.

You are indeed to be congratulated upon your ingenious invention.

Truly yours,

I. J. Paderewski

Patents applied for

Bel-Canto

The Superlative Loud Speaker

WE consider Mr. Paderewski's praise of the Bel-Canto Loud Speaker one of the highest possible endorsements of this remarkable instrument.

And it *is* a remarkable instrument. In no sense of the word is the Bel-Canto an ordinary loud speaker.

The Bel-Canto is a new and scientific instrument built on the most advanced principles of acoustics. Radio engineers and experts, radio dealers, radio fans, musicians and music lovers—all are amazed at the remarkable beauty of tone and the undistorted reproduction of the Bel-Canto Loud Speaker.

The Bel-Canto is constructed of reeds and metal in strict conformity to every known principle of acoustics. The sound is purified in a specially constructed chamber before being conducted through the reed amplifying tube to a metal resounding chamber. The result is a tone of such clarity and mellowness as to surpass any other amplifying device that we know of—even those selling at $100 or more. Yet the price of the complete Bel-Canto is only $30.

The Bel-Canto is a thing of beauty, sturdily constructed and handsomely finished in dull lacquer. It comes fully equipped with a special extra-sensitive loud-speaking phone, six foot cord and hard rubber plug—all ready to plug into your set. There are no extras to buy.

The Bel-Canto is tested for two stages of amplification on a regenerative circuit using at least 90 volts in the "B" batteries. After plugging in the Bel-Canto, tune your set to obtain the best results. No head-phones necessary.

The Bel-Canto is fully guaranteed. Entire satisfaction—or we will replace it with a new one, provided the plate on the bottom has not been removed.

Since our first announcement of the Bel-Canto we have been running to full capacity to meet the demand. And only by overtime work and increased facilities were we able to take care of orders. We are now in a position to supply any reasonable demand.

If your dealer has not yet stocked the Bel-Canto Loud Speaker, order direct from the factory—enclosing check or money order for the price, $30. The Bel-Canto will come to you prepaid and fully guaranteed.

Jobbers and Dealers—write for our proposition

Bel-Canto Corporation, 417 East 34th Street, New York

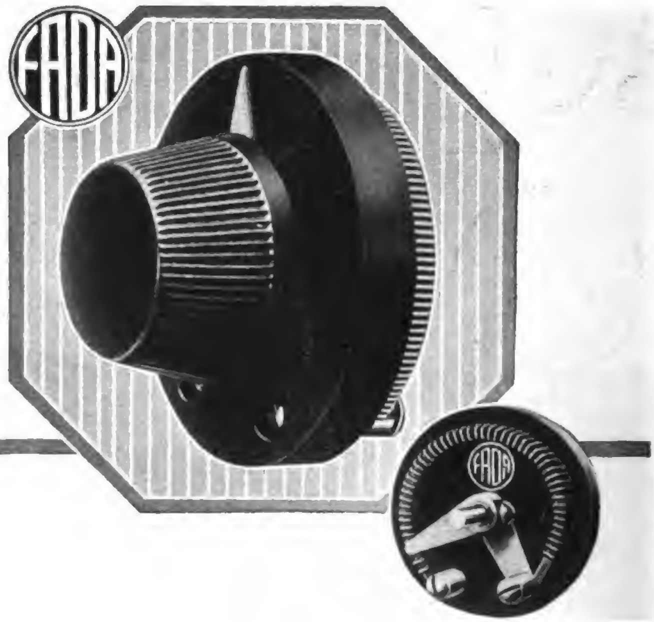
Popular Radio

NOVEMBER, 1922

15¢

HOOK-UP NUMBER

A
Better Rheostat
for 75 cents



Hard fiber resistor strip—will not absorb moisture or corrode wires

Half Million "Radio Fans" Bought Fada Rheostats in 1921

An unquestionable attribute to the merit of Fada rheostats is the universal approval of our half a million satisfied users.

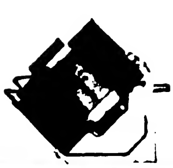
As a parallel to this achievement, Fada announces a new rheostat—a better instrument for less money. This new Fada rheostat, using a special hard fiber resistor strip, represents the pinnacle in rheostat design and finish.

This new fiber strip is specially treated and will not absorb moisture and corrode the wires. A notable advance in rheostat manufacture.

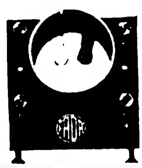
The new rheostat, as a whole, is designed, finished and appointed to attract those admirable radio builders who cannot be satisfied with inferior quality. Truly, this is the rheostat you can buy with supreme confidence; one you can assemble with genuine pride.

FRANK A. D. ANDREA
1581-D JEROME AVENUE, NEW YORK CITY

$4.75



$1.00



$35.00

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POPULAR RADIO

EDITED *by* KENDALL BANNING

CONTENTS *for* NOVEMBER, 1922

(Cover design by George Illian)

VOLUME II — NUMBER 3

VOLUME II — NOVEMBER, 1922 — NUMBER 3

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E. E. FREE, Ph.D., *Contributing Editor* LAURENCE M. COCKADAY, R.E., *Technical Editor*

"Without going out of doors,"
said Lao Tzu,
"one may know the whole world!"
"Let a Grebe Receiver
bring the whole world to your evening fireside."
Doctor Mu.
GREBE RADIO

A Page with the Editor

Not because we like to add to international complications, but rather because we believe that controversies between recognized authorities stimulate an interest in disputed points in science and lead eventually to an understanding of them, Popular Radio initiated the now-famous dispute concerning the "ether hypothesis" between Dr. Charles P. Steinmetz, representing the United States, and Sir Oliver Lodge, representing England, "both members of this club," to quote a sporting phrase. Sir Oliver's reply to the good doctor is published in this issue.

* * *

Next month Popular Radio starts another international controversy. Dr. Elihu Thomson, American, will lead off with an article that attacks the "Heaviside layer" theory; in the succeeding number Sir Oliver Lodge will defend it.

* * *

What other points in science need to be cleared up?

* * *

Although the broadcast concerts (initiated by Popular Radio) given at the City College Stadium in New York by the Philharmonic Orchestra took place in the middle of August, reports from listeners-in are still arriving. One of the first reports struck near home; it came from the brother of the chairman of the Concert Committee, who picked up the music unexpectedly on a vessel off the Massachusetts coast, several hundred miles away.

* * *

But perhaps the most unusual incident occurred on a Lackawanna train traveling fifty miles an hour through Pennsylvania—probably the first time that a symphony concert was ever heard on a railroad. A correspondent in Erie reports that the music was "just as loud and clear and well-modulated as any radio I ever heard. The music was received in the Library Buffet car, which was crowded with interested auditors at every performance."

* * *

Even the radio fans in far-away Morgantown, W. Va., picked up the performances of this great New York orchestra. "It was certainly a musical treat," writes John T. Hoffman, of that town. "Although a storm was approaching, the music came through very well."

* * *

Similar reports have been received from nearly a score of States. "There is no doubt at all in my mind," reports Dr. William H. Easton, of the Westinghouse Company, "that the total radius of this concert was over 1,000 miles wherever there was no interference from the broadcasting stations."

* * *

The May issue of Popular Radio contained 72 pages. This number which you are holding in your hand contains 116 pages—an increase of 34 pages.

Yet the price remains the same—only 15 cents.

* * *

Here's one request that the Editor just couldn't grant:

"I was reading De Maupassant's stories last evening," reports Howard Gould, of Boston, "when my October number of Popular Radio was brought to me. I laid down De Maupassant—and stayed up till after midnight reading your darned old magazine. Please don't make your November number so interesting; I need my sleep."

* * *

This number of Popular Radio contains 35 pages of advertising—*a net increase of 500 per-cent in seven months.* Advertising in Popular Radio pays.

* * *

Here is a letter from Joseph Warren, of Chattanooga, Tenn., that offers one explanation of Popular Radio's steady growth:

"When your magazine first came out I paid little attention to it. 'Merely another of those no-account radio publications,' I thought. But I changed my mind—and I changed because I found your articles authoritative and at the same time easy to understand. Simple language, clear and readable diagrams and illustrations, and writers of national standing combine to put Popular Radio in a class by itself. May Allah be praised!"

* * *

It is with particular gratification that the Editor learns that Popular Radio is commanding the recognition of the educational authorities; no greater compliment can be paid to any magazine than to be adopted in the nature of a text-book in the schools. "I have gone over the magazine with the Physics Department," writes Karl E. Whinnery, principal of the High School at Sandusky, Ohio, "and we want to subscribe. Send the bill to the Board of Education."

There's a real idea in that suggestion for school teachers elsewhere, especially physics teachers.

* * *

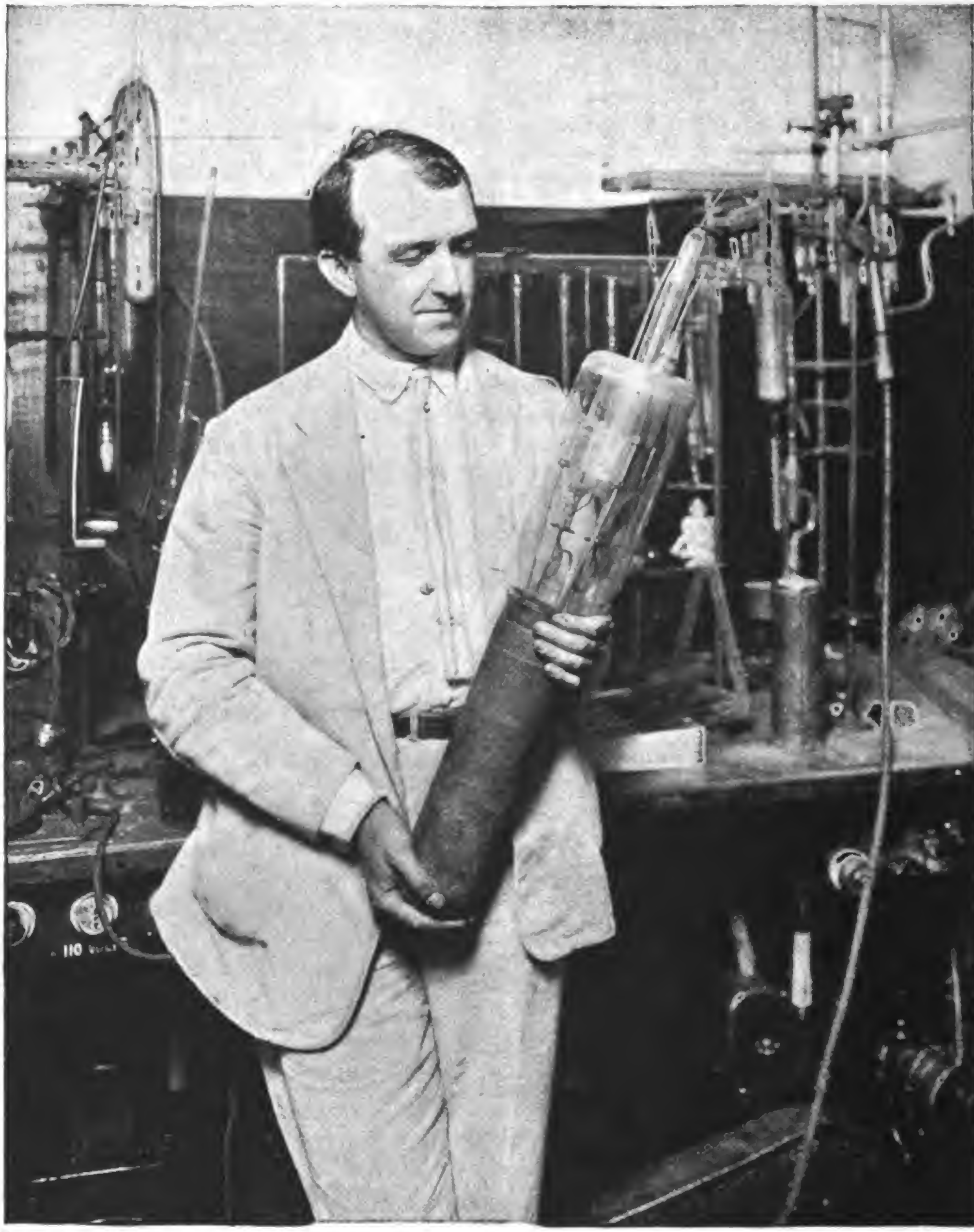
As a matter of fact, the value of radio as an educational force can hardly be overestimated. Not only is it of universal interest to pupils as an instrument in itself, but the character of the programs received is (or at least should be) of the greatest import. For it opens the way for bringing the world's greatest minds and the world's greatest music into the Little Red Schoolhouse.

Kendall Banning

Editor, Popular Radio

I have been in touch with your magazine and consider that the material in it is very useful and valuable.

Elihu Thomson



Western Electric

The Most Powerful Vacuum Tube in the World

While it weighs only ten pounds, it is capable of supplying 100 kilowatts of oscillating high frequency energy to an antenna. Just what this means in the development of radio may be visualized by the fact that two of these tubes operated in parallel would do the work of about $1,000,000 worth of the machinery that is now used in trans-Atlantic communication. The inventor of this remarkable tube, W. G. Houskeeper, is shown holding his invention in the laboratory where he built it.

Popular Radio

VOLUME II NOVEMBER, 1922 NUMBER 3

Are There No Ether Waves?

An English Answer to an American Scientist

FOREWORD

IN the July issue of this magazine was published an article by Dr. Charles P. Steinmetz, the eminent American physicist, who denied the the existence of the hypothetical medium known as "ether," and contended that the ether hypothesis was not necessary in order to explain the phenomenon of radio. This contention aroused world-wide interest in scientific circles, especially in England, where the physicists generally support the theories of Sir Oliver Lodge, who is regarded as the foremost authority on the subject—and who frankly disagrees with the American. Dr. Steinmetz, in declaring against the ether hypothesis, claimed that "There Are No Ether Waves" and that the ether is not required for the propagation of "radio waves"—the existence of which he does not deny. The following article has, therefore, an international aspect that gives it an unusual interest in scientific circles.—EDITOR.

By SIR OLIVER LODGE, F.R.S., D.Sc., LL.D.

THE Theory of Relativity ignores the ether of space, "having no need of that hypothesis." It treats of occurrences mathematically, from the point of view of the individual observer, and in terms of what he can observe. It is quite clear that we, as human beings, can observe only matter. That is what our senses enable us to perceive, and everything else is an inference. Mind, for instance, makes no direct appeal to our senses, and though it is the instrument of consciousness it is a philosophic question how far mind can be regarded as an object of consciousness. But we are directly aware that we are thinking beings, and therefore each individual concludes that he himself possesses a mind, or if he thinks deeper he may conclude that he is a mind and possesses a body.

By some means or other most people come to the conclusion that they consist of both mind and body, though how rightly to express the conjunction may be difficult even to a metaphysician. We do not, however, directly perceive the minds of other people; we only perceive their bodies, but those bodies look something like our own; and the way they act suggests that they are similarly each associated with a mind. That, however, is an inference, and there is a system of philosophy in which it has been argued against—the system known as Solipsism.

To commonsense, however, such a

system seems absurd, and we most of us are quite willing to make the inference that other people have minds like our own, whether we directly perceive them or not. There are many other entities in like case — lots of things which make no appeal to the senses directly, but which are inferred from the behavior of matter.

Life, like the life of a tree for instance, is of such a nature. We only infer that a tree is animated by something which we call "life" because of the way in which it grows and develops and fructifies and reproduces and decays. But many biologists have doubted the existence of any separate vital principle, and endeavor to treat the organism as sufficiently explained by the laws of physics and chemistry and by the interactions of molecules, the effects of which they observe.

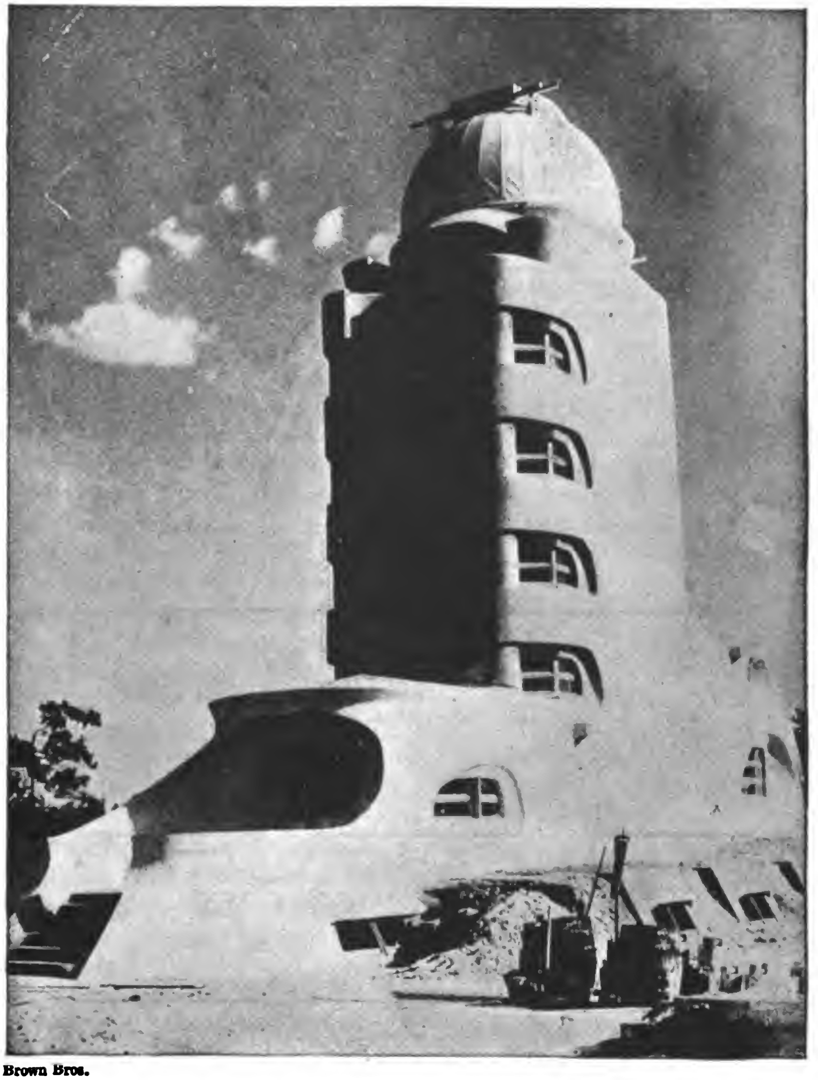
We might go further and say that electricity and magnetism are in a similar position. How do we know that such a thing as magnetism exists?

Only by observing the behavior of some kinds of matter—behavior which seems inexplicable unless we assume that it is, as it were, animated by something that we call magnetism, though we have no idea at present what it really is. It is hardly true to say that we have *no* idea; some of us have ideas, but there is no certainty about them. And I suppose it would be possible to work out a theory of the motions of matter without mentioning the term "magnetism" at all; for after all, by derivation, it only means the singular property of a certain stone which was found in Asia Minor. (The "lodestone," which pointed in a certain direction when suspended, and which imparted its property to steel, was supposed to have been first found near a place called Magnesia.)

But a gyroscopic compass points to the North, and the theory of its behavior can be worked out without reference to anything magnetic. Indeed there is nothing magnetic about it, it is only an elaborate spinning top. If we knew all about a compass needle it is probable that its theory could be worked out on somewhat similar lines. There is a hypothetical spin inside the atoms of the steel which may account for its behavior, just as the spin of the gyroscope accounts for its behavior, provided the spin of the earth is taken into account too. So it may be with magnetism. But no one has ever seen the magnetic spin, nor do we know for certain what it is that is spinning.

Again, we never actually see an electric current. What we observe is the motion of a compass needle which it deflects (as in a galvanometer), or the bubbles which arise in a liquid which it has decomposed (as in an electrolytic cell), or the light which is emitted by a filament which it has heated (as in an ordinary glow-lamp). No one has seen an electric charge. All we perceive is the behavior of bodies—the attraction of light things in its neighborhood; and to say that that behavior is due to an electric field, or that the pattern of iron filings is due to a magnetic field, is no better than saying that it is due to electricity or to magnetism. It might be difficult, but it would be possible, to work out a theory of the motions of matter without introducing those terms. And if we forcibly limited ourselves to that which was really and directly observed, such a theory would be the inevitable result.

That is what the Theory of Relativity aims at—to specify exactly what is perceived, and to make no hypotheses beyond it. If an observer fails to detect any difference in the velocity of light through space—whether he has reason to think he is moving toward the source or not—then let us proceed on the assumption that the velocity of light is absolutely the same relatively to every observer—granting the hypothesis, which is doubtful—for it *is* constant so far as the observer is concerned. If an observer is unable to detect any difference between his own motion and the motion of matter near



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THE BIRTHPLACE OF THE THEORY OF RELATIVITY

In this remarkable observatory, built near Potsdam, Germany, Dr. Albert Einstein evolved his famous theory which "dispenses with hypotheses and attends only to what can be observed and measured." Sir Oliver Lodge contends that these abstract factors must be reckoned with, whether or not we find that they can be "observed and measured."

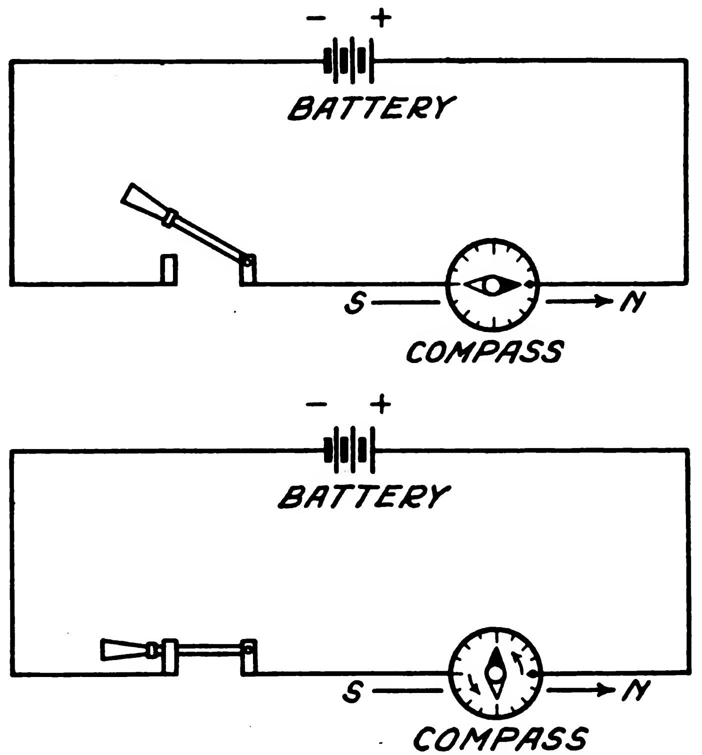
him, then let us assume that there is no difference, and that everything is as relative as it appears to be. So says the doctrine of relativity. In that way we get rid of the idea of absolute motion, that is of the motion of bodies referred to something which is not matter—something omnipresent and fundamental, in which matter, ever since Newton, has been hypothetically held to exist.

The Theory of Relativity is professedly a pragmatical and observational mathematical theory: hence it is claimed that it ought to be acceptable to physicists. It dispenses with speculation, dispenses with hypotheses and attends only to what can be observed and measured. At least that is its ideal, though whether it quite comes up to its ideal may be doubted. We will give it

the benefit of the doubt and assume that a theory of the universe can be elaborated without reference to anything but matter and its motion relative to other matter.

An interesting example of this kind of relativity is furnished by a letter in "Nature" for July 8th, 1922. A correspondent there points out that, of the two theories of the atom, one (namely Bohr's) requires the electrons to be revolving round a nucleus, while the other (Langmuir's) requires them to be stationary. He proposes a Copernican reconciliation, letting them be stationary while the nucleus spins on its axis, saying that according to the Theory of Relativity that should do just as well; in other words, that it does not matter whether a group of electrons revolve round a nucleus, or whether the nucleus rotates inside a group of electrons. Just so, according to an extreme relativist, it might be held that it makes no difference whether the whole system of stars revolves round the earth once a day, or whether the earth rotates diurnally on its axis.

Put in this way the notion is repugnant to commonsense and, we need not hesitate to say, is false. So also the reconciliation of atomic theories suggested in the ingenious letter to "Nature" is imaginary and devoid of efficacy. But according to strict relativity it is not so easy to say why commonsense comes to these conclusions. The fact is that



A DELICATE PROBLEM; HOW WOULD YOU DECIDE IT?

Sir Oliver points out that "Nobody ever saw electricity." But he also observes that "We do observe the motion of a compass needle which electricity deflects." For example, the upper diagram illustrates what happens when a compass is brought near a wire that has no current flowing through it; the lower diagram shows the change that takes place in the compass when a current IS flowing through the wire. Should we deny the existence of magnetism (or of the ether, for that matter) merely because our senses cannot yet perceive the agencies that produce the phenomena? Sir Oliver Lodge answers "No."

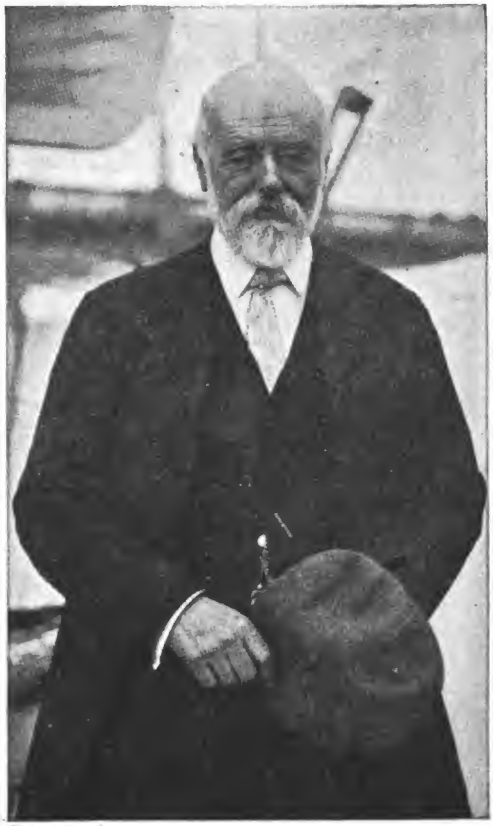
the centrifugal acceleration required for radiation cannot be conferred on an electron by a relatively rotating nucleus. Nor is it possible for the stars to move far quicker than the velocity of light—as they would have to if they were to revolve round the earth.

For what, after all, is the velocity of light, and why should a thing be unable to move faster than that?

If we wholly and finally ignore the ether, no explanation is forthcoming. We can only merely say that it is so. Relativists all agree that it is so—the equations demonstrate that—but by pure relativity they cannot explain why.

Hence those who have gone most deeply into the Theory of Relativity sooner or later perceive that there must be something substantial filling otherwise empty space; in other words that the ether is really and truly indispensable, however much for practical purposes it may be ignored. For though we can proceed a long way without mentioning or thinking of it, sooner or later it is bound to make its existence felt, not physically, but mentally, because of certain physical effects or consequences which are inexplicable without it, and because its existence is necessary to clear and adequate conceptions. To put it in the most ordinary and elementary form, one cannot really think of waves without some substantial medium for their conveyance.

Let it be known then that the great apostles of relativity have never denied the existence of ether. They have dispensed with mentioning it as far as they can. It does not seem essential to their theory as far as that has been worked out. It does not seem amenable to direct experiment; and they can write down their equations without attending to it. But to deny the existence of the ether, or of electricity, or of magnetism or life or mind, merely because we find it possible for many purposes to ignore them, is to stultify ourselves. And to accuse any of the great relativists of denying the existence of an ether is to attribute to a man of genius a stupidity which he is very far from exhibiting—still less of possessing.



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TO DENY THE EXISTENCE OF FORCES WE CANNOT PERCEIVE IS "STUPID"

So states Sir Oliver Lodge in his spirited defense of the ether hypothesis. "One cannot really think of (radio) waves without some substantial medium for their conveyance," he argues. Sir Oliver was president of the Physical Society of London, 1899-1900; President of the British Association, 1913-14, and the recipient of the Rumford Medal of the Royal Society and of the Albert Medal "as a pioneer in wireless telegraphy." Among his twenty volumes on scientific subjects is "The Ether of Space."

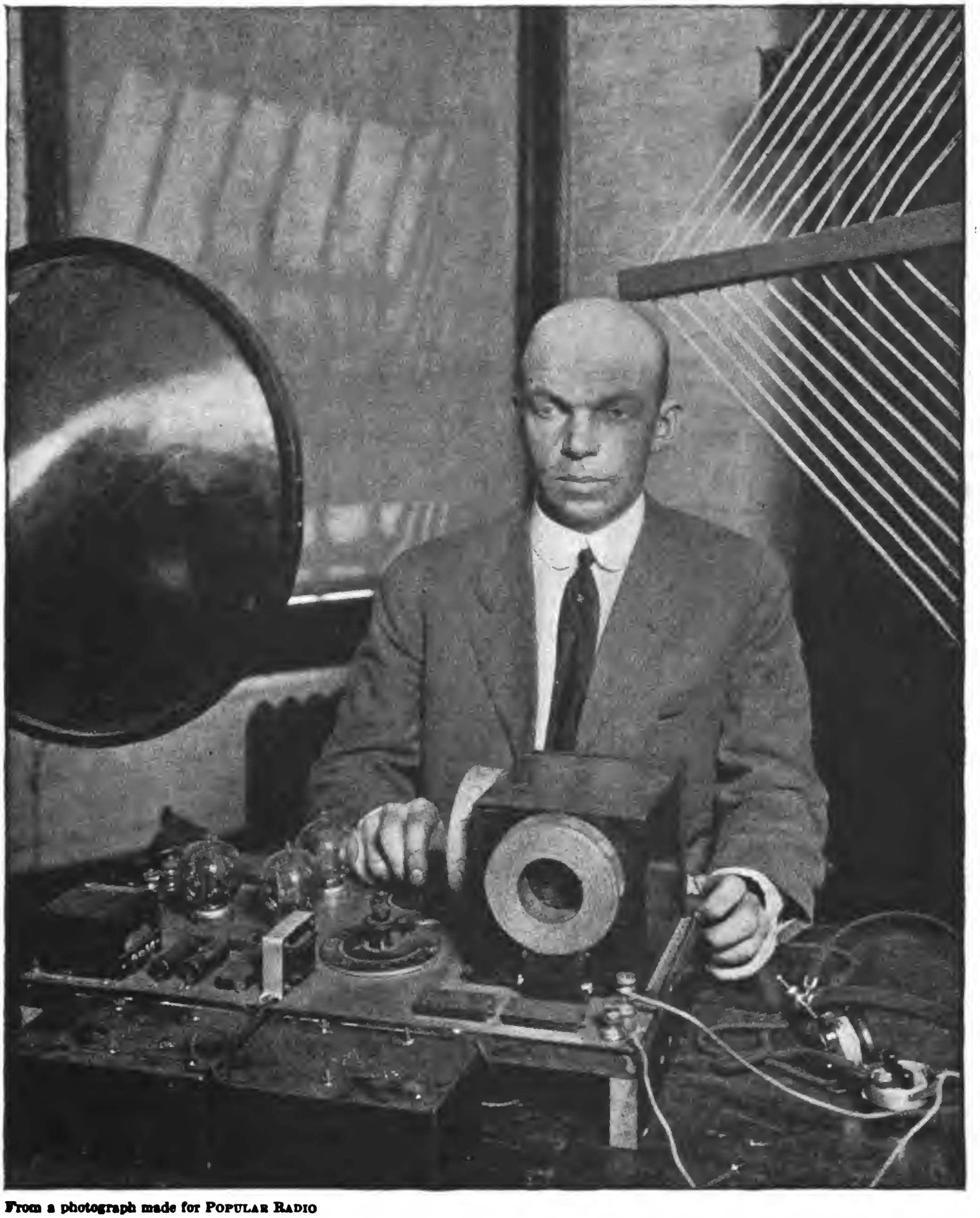
How then is it possible for Dr. Charles P. Steinmetz to lay down the law and to say that "there is no ether," that "there are no ether waves," and that "according to the Theory of Relativity there can be no such thing"; and that no carrier for light or electro-magnetic waves is needed?

Plainly because he has gone a certain distance into the Theory of Relativity, and has not emerged into the atmosphere beyond it. He is satisfied with the way in which it works out the motions of matter as observed by the senses, and he considers that any inferences beyond the immediate testimony of the senses are illegitimate.

That, then, is where we part company. To limit ourselves to sense indications alone is to reduce ourselves to the level of animals. No one really does it; and some even of the animals may make inferences of a kind. Certainly it is our human privilege to discover, to infer, to generalize and to predict. And I advise those who are every day using the ether, for electrical and magnetic and optical purposes, not to confuse themselves with the gratuitous and rather stupid hypothesis that matter is all that exists because matter is all they perceive; but to allow their minds freer play, and to realize that manv other things exist too, for which we have no sense organ.

So, if they care for my advice, I will recommend them to use a nomenclature in accordance with commonsense; to give a name to the substance or medium in which all their phenomena are occurring; to realize that wherever there is an electric field or a magnetic field or a gravitational field or a beam of light, there must be something going on in this medium—something which physicists can hope to analyze and examine and reduce to law and order. I would urge them not to remain satisfied with an abstract statement about the existence of unexplained forces in an absolutely empty, unphysical and merely geometrical space.

A field of force in vacua has to be accounted for: the mere statement that it exists is no theory. A theory of the ether has not yet been worked out, it remains for the next generation of workers to do it. Perhaps some of those now living will lend a hand. It is no easy task. Meanwhile we can remember always that the properties of the ether are largely unknown and remain to be discovered: which surely is a stimulus to us to pursue our researches. That which we know definitely about it, so far, is the rate at which it can transmit waves, and we know also a great many things which follow directly therefrom. We know further that it has properties akin to elasticity and inertia, which are experienced respectively in electricity and magnetism. Again we know (through the genius of Clerk Maxwell) that the combination of these two properties gives rise to that special kind of disturbance which stimulates the eye, and is responsible for all that is experimented on in wireless telegraphy.



From a photograph made for POPULAR RADIO

THE MAN WHO ORIGINATED THE ARMSTRONG CIRCUIT

Hertz, Marconi, De Forest—and now Edwin H. Armstrong head the list of scientists who have made radio, as we know it today, possible. Armstrong has the unique honor of making three definite contributions to radio. FIRST, *he originated the regenerative feedback vacuum tube circuit.* SECOND, *he invented the super-heterodyne receiver—the most sensitive receiver ever produced.* THIRD, *he invented the super-regenerative receiver, which has just taken the world by storm, and which bears his name. Detailed instructions for building this super-regenerative receiver were published in* POPULAR RADIO *for September.*

My Orchestra of AUDIONS

Every radio fan who has heard the audio frequency "howling" of a home-made receiver will recognize the raw material from which the notes of this remarkable instrument are built and how wonderful musical tones are created by varying the inductance or the capacity of the vacuum tube circuit.

By
LEE DE FOREST, Ph.D.

Photo by Paul Thompson

THE undeveloped talents of the audion tube are undoubtedly numerous. One might let his imagination roam at will among its possibilities and never touch upon more than a small fraction of the applications some day to be discovered; many of them, doubtless, by the thousands of radio amateurs who are now free to pursue this still adventurous search.

There is one phase of audion application in which I have always had a deep personal interest. This application does not lie in the field of practical utility, but in the world of art and imagination, in the province of music.

For, in addition to its many other magic feats, the audion may be used to produce musical harmonies far more beautiful than those of any musical instrument yet devised.

Music from the audion! That is the theme which I suggest to those who are interested in the undeveloped possibilities of the vacuum tube.

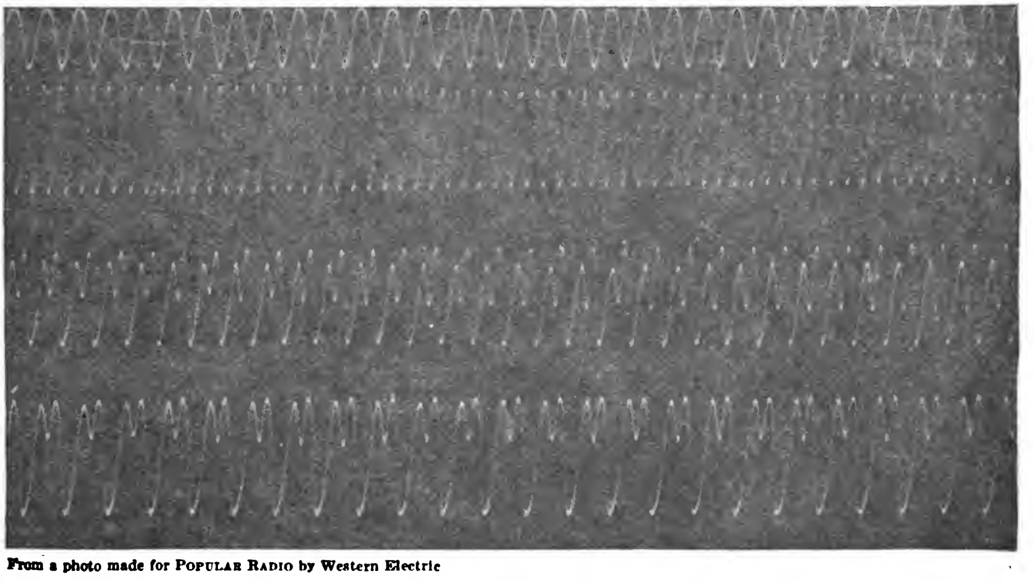
The audion serves not only as a detector, an amplifier and a high-frequency generator, together with a score or two or other uses in electrical engineering: it will serve also as a musical instrument, an instrument of astounding possibilities.

It is quite possible, I believe, that the musical audion, when fully developed and perfected, will revolutionize altogether the production of music. It will supersede our organs and pianos, even perhaps our symphony orchestras, just as these have superseded the musical instruments of ancient times, the lyre, the tambor, and the Pipes of Pan.

This musical phase of audion possibilities is not a new idea, though it is one long awaiting development. Back in 1915, following the use of the audion in the record-breaking radio telephone demonstration from Arlington to Honolulu, I made an announcement of what was then the promise of an early use of this magic tube as a producer of music. I pointed out that the tube was a device capable of producing musical notes of rare beauty and great range; an entirely new music of surpassing volume and harmony.

It was while developing the audion as a wireless telephone detector, and as an amplifier to be used on long-distance telephone lines, that I made the discovery of audion music. I found that when the circuits of an audion tube were adjusted in a certain way, so that electrical oscillations were produced, I could hear a clear musical note in the connected telephone receiver. The quality of this note was exceptionally beautiful. After later experiments I found that I could change this quality of tone so as to produce a great variety of sounds—imitating, for example, the flute, the oboe, the cornet or stringed instruments. I could also produce other sounds which, while pleasing to the ear, were quite unlike the tones emitted by any of the musical instruments with which we are familiar.

The pitch of the note could be regulated, I found, by changing the capacity or the inductance of the circuit, this being accomplished easily by means of a sliding contact on the inductance coil or



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PHOTOGRAPH OF THE NOTES OF A FIFE

This oscillograph shows (at the top) a pure sine wave of 1000 cycles a second; the second wave from the top shows the highest note of the fife, which has practically no harmonics. The presence of harmonics is clearly shown on the two lower waves.

by turning the knob of the condenser. I found, indeed, that I could change the pitch of the note by merely touching my finger to certain parts of the circuit, and by so doing I was able to obtain many weird and beautiful sound effects. Another method of varying the pitch was by means of a black lead pencil mark drawn on a piece of paper or a slate and connected across certain parts of the circuit.

Every one is familiar with the peculiar plaintive notes produced by the Hawaiian guitar when the player slides a piece of steel along a string previously set in vibration. Much the same effect can be obtained with the musical audion by varying gradually the pitch of its note. Other effects include the shrill warble of birds, staccato drumbeats, heavy organ peals and notes closely simulating those of the familiar orchestral instruments. Even in our preliminary experiments we succeeded in producing new tones, tones far more ethereal and beautiful than any now at the command of musicians.

The reason why these effects were possible will be clear at once to radio engineers. Musical tones are simply air vibrations or oscillations that have frequencies within the audible range. That is, they have what we call "audio frequencies." On the other hand, the electric oscillations in a vacuum tube, for example in a tube which is being used as a generator of oscillating current or as a transmitter for continuous wave radio work, are much more rapid than the oscillations of sound. They have higher frequencies or what we call "radio frequencies." All this is familiar.

But vacuum tubes can be made to oscillate not only at the high radio frequencies, but also at the much slower audio frequencies. This, indeed, is just what the tube does when it goes wrong temporarily and howls into the telephones of a radio receiving set. It is oscillating at a comparatively low frequency, a frequency within the audible range.

All that we have to do to bring this about artificially is to arrange a partial feed-back circuit containing the proper inductances and capacities to produce just the frequency, that is, the tone, which we wish. The electric oscillation thus produced, being already of audio frequency, requires merely to be fed into a telephone or loudspeaker in order to give us ordinary sounds in the form of a musical tone.

The note of an organ pipe is produced by the oscillation of the air-column inside the pipe. The note of an audion tube is

George Granthans Bain

HOW THE "AUDION ORGAN" MAY BE PLAYED

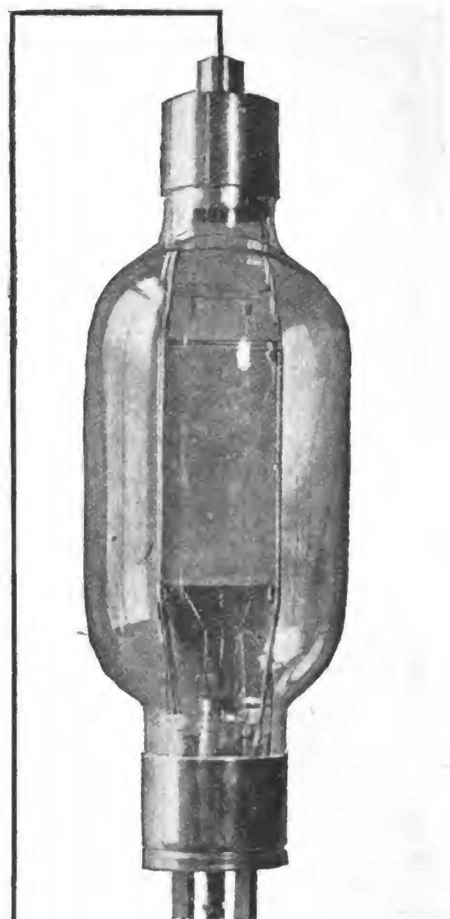
By means of vacuum tubes, a loudspeaker, and a suitable audio frequency oscillating circuit connected to a keyboard—similar to a piano or organ—music of exceptional tone flexibility and wonderful sweetness may be produced. The apparatus may be controlled by "stops" as in the organ, so that the various musical instruments may not only be imitated, but other tone qualities may be produced that are unknown to the musical world today.

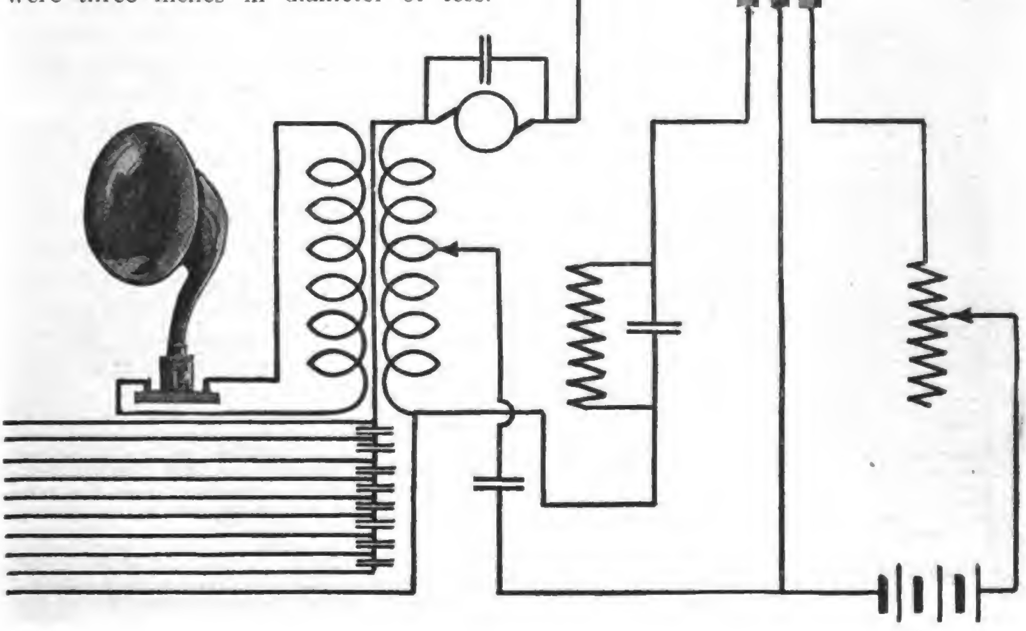
produced by an electric oscillation in the tube circuits. To change the pitch of an organ pipe one changes its length, thus altering the frequency of the oscillations of the air-column. To change the pitch of the musical audion one changes the inductance or the capacity, thus altering the frequency of the electric oscillations. Either an organ pipe or a musical audion circuit may be built or adjusted to give out a tone of any desired pitch.

My next step in the development of the musical audion was to arrange a scale similar to that of a series of organ pipes. In this audion organ, however, we used switches in place of the ordinary organ keys. By pressing certain switches we cut in or out of the circuit more or less of inductance or of capacity, thus changing the frequency of the oscillations in the tube and controlling the pitch of the note emitted from the telephone receiver.

To give volume to the music we connected a number of loudspeaking horns in place of the telephone receiver. With these horns distributed in different parts of the laboratory, or grouped together in one place, we secured many novel effects in the way of our synthetic music.

The bulbs used in these experiments were three inches in diameter or less.





We used one bulb for each octave of the musical scale. By an arrangement of switches in place of keys, we could produce from this one bulb, by pressing the right switch, any of the notes of that octave. Another bulb was used for the next octave, and so on. The output of all these bulbs was fed into one set of telephone receivers or loudspeakers, so that the total energy emitted in the form of sound was that of all the circuits in action at any one time. It included all of the notes being sounded by the tubes, just as orchestral music includes all of the notes being sounded at one time by all of the instruments which are playing.

These experiments of mine were carried out six or seven years ago. There had been, however, some still earlier attempts to produce electrical music in other ways, not using the audion. Notable among these were the experiments of the Cahil Company with what was called the "telharmonian."

This instrument was a huge plant consisting of a large number of alternating current generators of the inductor type. Each of these generators produced a current of a certain definite number of alternations a second, and each was tuned to the frequency of one of the notes of the musical scale. There was a different generator for each note, just as a piano has a different string for each note.

The currents from these generators were controlled by a keyboard similar to that of an organ and were combined thus into a single, highly-complex musical current which was transmitted over the telephone wires to theaters, hotels and homes, where loudspeaking horns poured this new electrical music into the air. There were imitations of the organ, the

LOWEST AND HIGHEST SOUNDS PERCEPTIBLE TO THE HUMAN EAR

Of the thirty instruments of the modern orchestra, the lowest pitch is that of the tuba (32.7 vibrations a second), and the highest is that of the piccolo (4,752 vibrations a second). Radio frequency currents in general use range from 30,000 to 1,500,000 vibrations a second; the highest audible vibrations range up to 40,000.

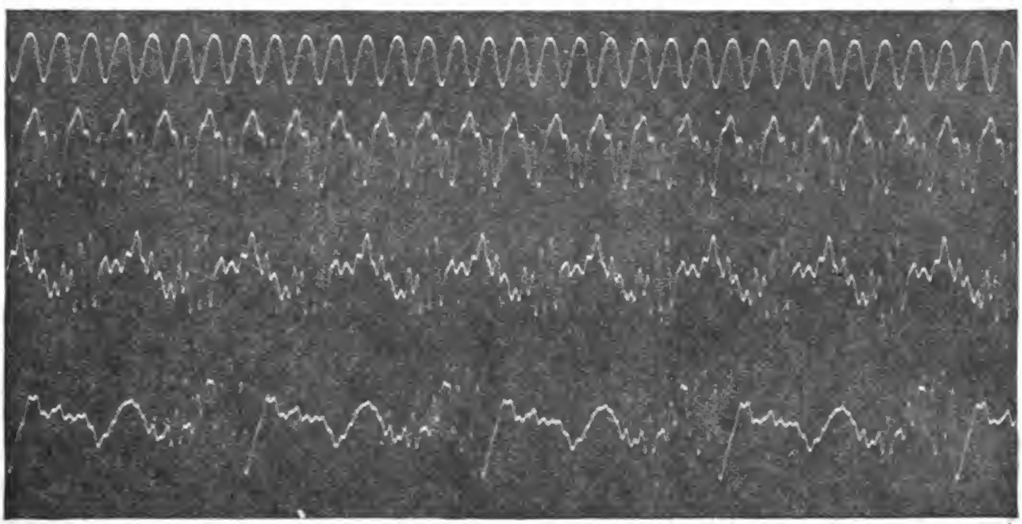
clarinet and other instruments, and mingled with these were strains of a quality entirely novel to musicians.

In comparison with the telharmonian, the musical audion has the advantages of greater flexibility and ease of control as well as of simplicity. As a source of musical tones an audion is equivalent to, indeed it is superior to, the alternating current generator, but at a small fraction of the cost, bulk and weight. The necessary parts of an audion organ might be contained in the cabinet of an ordinary talking machine and with a control the size of a typewriter keyboard. With the audion organ there are no pipes or strings to require great bulk, and yet it will produce music ample to fill a large auditorium.

The greatest advantage of the audion organ lies, however, in the increased tonal resources which it puts at the service of the musical composer. Musical tones differ among themselves in three qualities: pitch, loudness and quality. The pitch is simply a matter of frequency; the greater the frequency, the higher the pitch. Loudness explains itself; tones may be either very strong and loud, or very faint—or anything in between. Both of these two characteristics of a tone are fully controllable in the audion organ; pitch, as I have explained, by varying the frequency of the electric oscillation, loudness by varying the input of energy with a resistance or in any other convenient way.

But the third characteristic of tones, the tone quality, the audion organ also permits us to control; and it is this, I imagine, which will be of the most interest to the professional musician.

The differences in the sound of the various musical instruments are due almost altogether to differences in the quality of their tone. Middle C of the piano has a pitch or frequency of 262 vibrations a second. This same note played on a violin or on a clarinet or on a French horn has exactly the same frequency, 262 a second. Yet the notes from these different instruments do not sound alike. You can tell easily that one of the notes is from the piano, another from the French horn. What are the differences?



From a photo made for POPULAR RADIO by Western Electric

THE TONES OF A SAXOPHONE—THE INSTRUMENT RICHEST IN HARMONICS

Compare the record of harmonics (illustrated by the frequencies in the three lower waves that record three different notes of a saxophone) with the pure sine wave at the top.

They lie in the tonal quality, and this tonal quality is a matter of what are called "overtones." A pure musical tone is a simple and regular vibration. It is represented by a pure sine-wave curve, like the curve of a perfectly regular alternating current.

Incidentally, such an absolutely pure tone cannot be produced by any ordinary musical instrument and only with great difficulty by the human voice. All ordinary musical tones contain certain overtones superposed on the pure tones. These overtones are tones of higher pitch, that is, of higher frequency, which are sounded at the same time as the pure tone and blend more or less completely with it. The overtones produce little bumps and hollows, little kinks, in the sine-wave of the pure tone. Or they displace the maxima and minima of the wave, so that the original sine-wave is no longer exactly even and symmetrical. In electrical language they "distort the wave of the sound."

This distortion is what produces tone quality. A piano note has a certain fundamental tone, a pure symmetrical sine-wave, corresponding to the pitch of the note. It also has certain overtones, corresponding to vibration of the piano string in parts, in halves or thirds or quarters. It has certain other overtones, corresponding to parts of the sounding-board or to other strings. The actual tone is the sum and combination of all these tones. The overtones distort the sine-wave of the pure tone. They give it its quality, so that you recognize it as a piano tone. If your ear is very good you may be able even to recognize it as a tone from a certain individual piano or from a piano of a certain make.

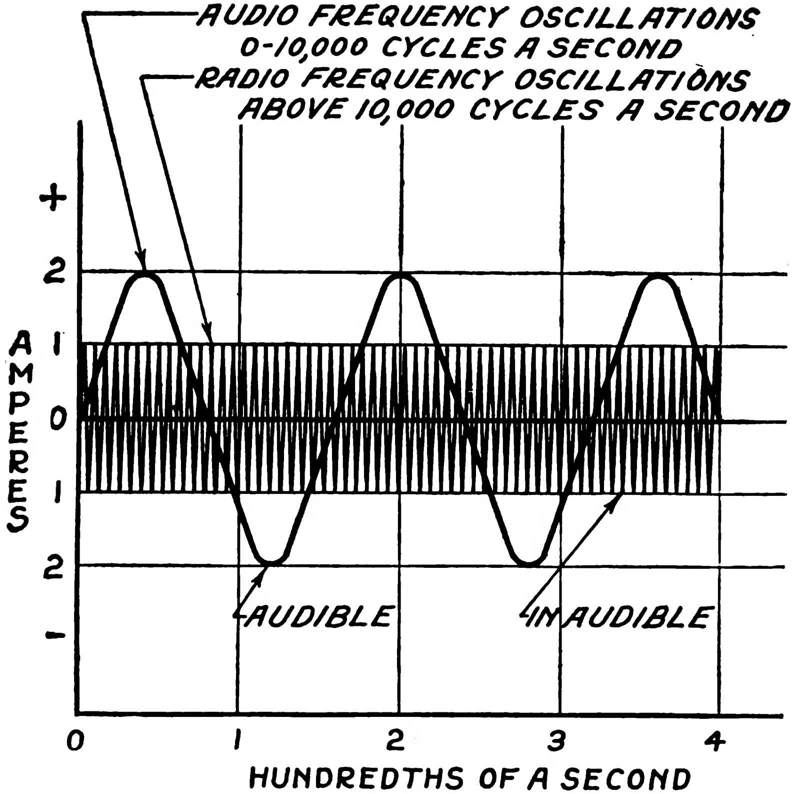
Similarly with other instruments, each one has its own set of overtones which it imparts to its fundamental tone. Each one has its own tone quality. To some extent this quality can be controlled by the musician, as when a violinist changes his tone quality by varying his bowing, or when a horn player sticks his fist into the bell of his instrument in order to get the so-called "stopped" quality into his tone.

Now all of these variations of tone quality are obtainable—and controllable—with the audion organ. The musical audion may be adjusted so that its primary tone is absolutely pure, a perfect sine-wave. Or this primary tone may be altered merely by distorting the electric circuits, so as to cause any desired change in the quality of the sound. It may be made to counterfeit the piano, the violin, the 'cello or the horn, or may be distorted into any sort of sound—musical or grotesque.

Furthermore, the note of the audion tube is controllable in pitch with extraordinary precision. It may be altered not only in steps of a full tone (as in most instruments), but by half tones or quarter tones or even lesser fractions. It may be played so as to be always precisely in tune, an advantage which it shares only with the violin and other bowed strings and with the slide trombone. All other instruments, among ordinary ones at least, have a fixed series of notes. Only these notes can be played, and the musician can alter the pitch of these, while playing, only slightly, if at all.

On the piano, for example, D sharp and E flat are the same tone, produced from the same string. Every musician knows that this is not quite as it should be. D sharp and E flat ought to differ a little in pitch. One or the other should be used depending upon the exact harmony desired. But to insert both in the piano would require too many strings and keys. One note, about half way between the two, must serve for both. The entire piano keyboard is a compromise between musical desirability and mechanical necessities. Its scale is not, it cannot be, exactly perfect.

Other instruments have similar imperfections. Their scales are never quite perfect. Their harmonies are always a trifle untrue. Only the violin and its lower-pitched analogues, the viola, the



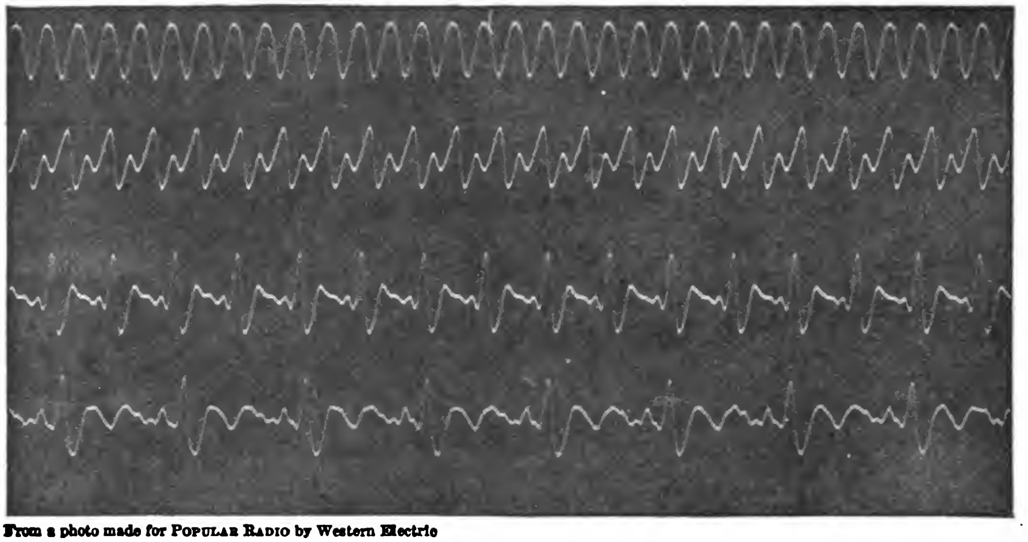
VIBRATIONS THAT WE CAN HEAR—AND THAT WE CANNOT

This diagram shows two alternating current waves. One is one of a frequency that we can hear and one is of a frequency that oscillates so fast that the human ear cannot detect it. The latter is used in radio communication and is usually produced by the vacuum tube. The vacuum tube may also be used to produce the audio frequency oscillations which are used by De Forest for the production of the wonderful new music described in this article.

'cello and the double bass; the slide trombone; the human voice—and the audion tube—can be made to produce absolutely true tones, absolutely perfect harmonies.

In precision of control for both pitch and tonal quality, the audion tube equals or surpasses all other instruments. It has, as the musicians say, great flexibility, a flexibility exceeding even that of the full orchestra.

The modern symphony orchestra contains 25 to 30 kinds of instruments. Allowing for the possible different ways of playing some of these instruments, the composer has at his service perhaps one hundred different kinds of tonal quality. His available pitch range is from the highest D of the piccolo, at 4,752 vibrations a second, to the lowest C of the mutiple-valved tuba, at 32.7 vibrations a second. He can widen this pitch range a few notes if he has an organ for very low tones or if his violinists can play the six or seven possible harmonics which range above the piccolo. But his available range of tone quality and his available range of pitch do not fully coincide. He cannot play high notes of bass-horn quality nor low notes that sound like the piccolo or flute. The flexibility of the orchestra, its resources of tone color, or expression or emotional portrayal, while very great in comparison with the piano or with any other single instrument, is still far from being as complete as is possible in theory.



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PORTRAIT OF THREE NOTES OF A CORNET

Note the first harmonic (one octave above the fundamental) in the wave below the pure sine-wave. In the record next below there are numerous harmonics which are increased further in the lowest wave.

The whole history of instrumental music may be regarded, by the way, as a more or less successful effort by musicians to widen the flexibility of their instruments, to increase the sum-total of their tonal resources. The original instruments of primitive man appear to have been two, the simple pipe or whistle and the drum. To these the ancients added a third fundamental instrument, the stretched string or lyre. These three possessed a very small range of pitch and a still smaller range of tonal quality.

It was the effort to increase this range that led to modern instruments. Out of the pipe grew first the notched or holed pipe which could play several notes and which survives in the modern flute. Then came the combination of several pipes fastened together in a row. These could play not only a note for each pipe, but the quality could be varied by using narrower and wider pipes or by making them out of different materials. Hence the Pipes of Pan or syrinx; and out of this there came, by direct and traceable descent, the modern organ.

The primitive stringed instrument, the lyre, developed even more widely in the direction of greater flexibility. Pitch range was attained by the device of changing the string length with a moving finger, as in the modern violins. A marvelous increase in range of tonal quality followed the invention of the bowed or scraped string to replace the original plucked string.

Even the drum followed suit in the search for greater flexibility. We have now the tuned drum or kettledrum, the various tone qualities of small drum, base drum and tambourine, and, in addition, the triangle, cymbal and others, which are really only kinds of drums made out of metal, and made thus in order that the tone quality might be different, that the composer's available range of quality might be widened still a little farther.

Finally, we have the modern orchestra, its available musical resources so wide that they would have been totally inconceivable, I suppose, to a musician of ancient Greece or Rome, even perhaps to the religious choristers of only two or three centuries ago.

Is this the final step? Has the orchestra as wide a range of pitch and tone quality as we will ever be able to attain?

I think not. I believe that the musical audion will soon be able to widen greatly even the great flexibility of the orchestra. Audion tubes can play notes of any pitch; even, if necessary, notes several octaves above the piccolo or the violin harmonics. And they can play all of these notes, high or low, with any desired tonal quality; with the quality of horn or oboe or 'cello, or with new qualities not yet known or used.

What a resource for the composer! What possibilities of new orchestration, of undreamed of harmonies and melodies, tone colors and emotional effects!

Of course we must not expect that the development of the audion organ will be entirely free from practical difficulties. At least two of these difficulties can be foreseen already. One is that of arranging a tube circuit which will be perfectly stable, so that the tone of the tube will not vary, even ever so slightly, after it has been once adjusted.

The second difficulty is the devising of a precise, rapid and dependable system of control, an equivalent of the keys and valve mechanisms of the ordinary organ. Mere switches and condenser knobs are neither precise enough nor quick enough.

At the moment these practical obstacles look pretty serious. But obstacles have a way of disappearing as we approach them more closely, especially where the audion tube is concerned. Probably obstacles to the development of the audion organ will be no exception.

In all my work with the audion—and I can imagine no device in the wide range of practical physics which has greater fascination than this little bulb—I have found no phase of its possibilities quite so interesting as this one of the production of musical tones. Certainly the idea of producing beautiful tone effects by such an entirely new method, unknown to our great composers, offers to musicians an alluring field for their genius.

In the audion we shall have an instrument suitable for home entertainment as well as for furnishing music to a big auditorium. And music thus produced may be taken up again by the audion, this time for broadcasting, and finally received by the countless other audions of receiving sets throughout the world. The musical audion, the radio transmitting audion and the receiving audion, each one doing its share toward the enrichment of life!

The Master's Voice

Our esteemed (if somewhat more elderly) contemporary, the London *Punch*, recently published a satirical drawing of a Vicar and a Verger regarding an empty church.

"This is terrible," observed the former, "five minutes before the service and not a soul here!"

"No, sir," replies the Verger, "but I understand there are some thousands waiting in their own homes to listen in."

In the United States the satire of this observation would be lost—simply because it reflects a truth. The accompanying picture was snapped in a Pennsylvania farmhouse during divine service by radio.

From a photograph by P. A. Sensenig

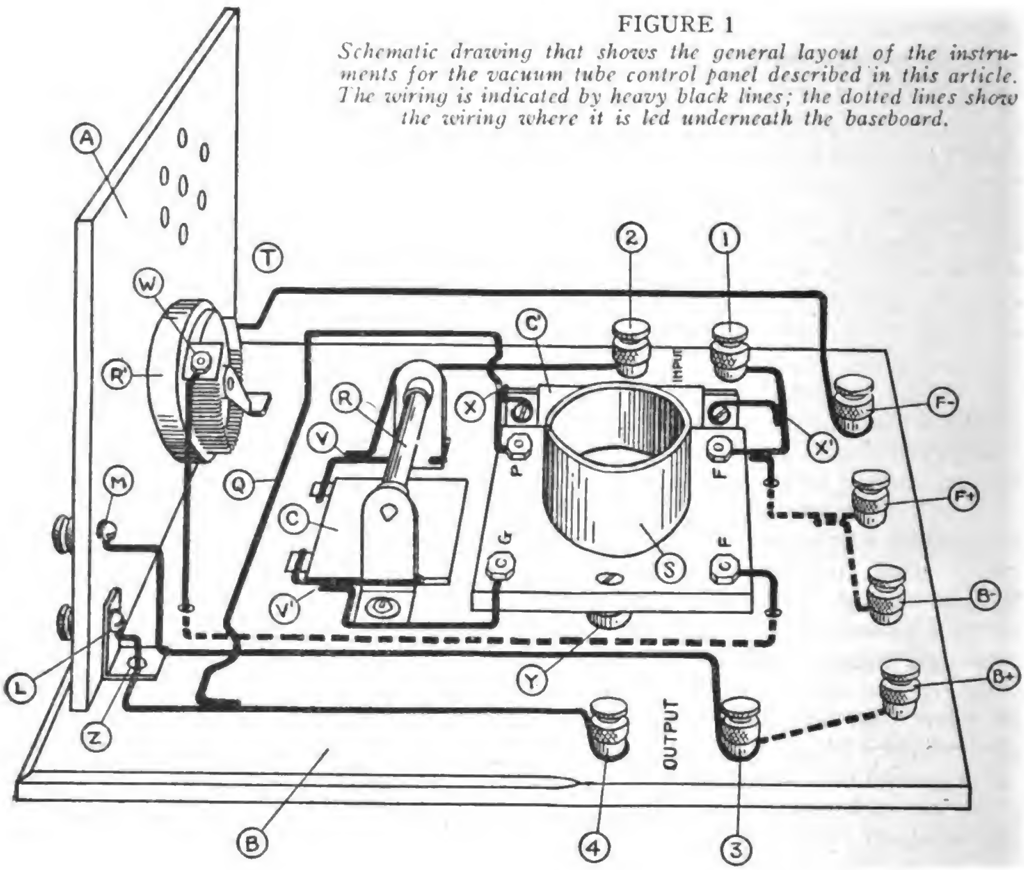

FIGURE 1
Schematic drawing that shows the general layout of the instruments for the vacuum tube control panel described in this article. The wiring is indicated by heavy black lines; the dotted lines show the wiring where it is led underneath the baseboard.

How *to* Add a Vacuum Tube *to* Your Crystal Receiving Set

THE COST OF DOING IT—

Electron tube	$5.00 to $6.50
Electron tube socket	.75 to 2.00
Filament rheostat	1.00 to 2.50
Grid leak and grid condenser	.50 to 1.50
By-pass condenser (about)	.35
Ten feet No. 14 bare tinned copper wire (about)	.10
Miscellaneous binding posts and screws (about)	.75
"A" storage battery, 6-volt, 60 ampere-hour capacity	15.00 to 20.00
"B" battery, 22½ to 45 volts	1.00 to 3.00
Total cost	$23.25 to $36.70

By WATSON DAVIS

THOSE radio fans who made the crystal receiving sets that have been developed by the Bureau of Standards in Washington and that have been described in detail in this magazine,* have apparently found their modest experience with radio so interesting as to stimulate a desire for a receiving set of greater efficiency. In response to this demand, Uncle Sam has produced another set of specifications—a new and better set that employs the same tuning inductances as the two previous sets but that substitutes a vacuum tube detector for the crystal detector.

These new specifications enable the builder of the crystal sets to convert

*See "How to Make and Install Your Own Receiving Set" in POPULAR RADIO for May, 1922, and "How to Make and Operate a Two-Circuit Receiving Set" in the July issue.

them into tube sets at a cost ranging from $23.00 to $37.00. Thus altered, the new sets are capable of receiving high-powered transmitting stations at a distance of about seventy-five miles, when they operate on wavelengths from 200 to 600 meters. Under good atmospheric conditions broadcasting from distant stations may be heard, especially at night. The simple electron tube detector circuit will not, however, make "continuous-wave" signals audible.

The instructions issued from Washington describe simple apparatus of satisfactory performance without reference to the possible existence of any patents which might cover parts of the apparatus. Apparatus in general similar to that described can be purchased from responsible manufacturers and dealers.

The Essential Parts of the Set

The complete radio receiving equipment may be divided as follows: antenna, lightning switch, ground connections and telephone receivers. These are completely described in the May issue of this magazine.

The tuning device. This may be the tuning coil described in the May issue of POPULAR RADIO or it may be the two-circuit coupler and variable air condenser described in the July issue. While the two-circuit tuner will be somewhat more selective than the single-circuit tuner, its use is not absolutely essential. The two-circuit tuner is also more difficult to operate than the single-circuit tuner.

The electron tube detector unit. This is shown in Figures 1, 5, and 6. It is composed of a baseboard B and an upright panel A. On the baseboard B is mounted an electron tube E, shown only in Figure 5, an electron tube socket S, a grid leak R, a grid condenser C, a by-pass condenser C^1, and eight binding posts. On the upright panel A is mounted a filament rheostat R^1, (the adjusting knob J is shown in Figure 5), and two telephone receiver binding posts L and M. The parts S, R, C and C^1 are also shown in Figure 3. Later it will be told how the various parts are assembled on the baseboard and the panel. No description is given of how the parts E, S and R^1 are made because these are all commercial articles. It is, of course, possible for one to make parts such as the electron tube socket S and the filament rheostat R^1.

The accessories needed are a six-volt battery, used for lighting the filament, often called the "A" battery, with an ampere-hour capacity of about 60; a 22½ to 45-volt dry battery, called "B" battery; binding posts; stiff copper wire; wood boards for the baseboard and upright panel, and two brass angle braces for supporting the panel. The "A" and "B" batteries are shown in Figure 5. The "A" battery will usually be placed on the floor beneath the table upon which the other parts of the equipment are mounted. Its comparative size is much reduced in the drawing. An insulating material panel may be substituted for the wood if desired. The electron tube detector may also be entirely enclosed in a wood cabinet with a hinged cover, if desired.

Details of Construction

The baseboard (See B, Figures 1 and 3). The base B is any kind of dry wood about 6¼ inches by 8¼ inches by ¾ inch thick. Eight holes are drilled through the base in which the binding posts are fastened. The spacing of these holes is shown in Figure 3. By the addition of two more binding posts properly connected, this detector may be used in a "regenerative" circuit when the binding posts are externally connected to a "tickler" coil coupled to the tuner. These binding posts are added to the detector baseboard B in line with the "input" binding posts Nos. 1 and 2. (See Figure 1.) They are 7/32 inch from the edge of the baseboard, and the four binding posts are arranged in such a manner that they are equally spaced, 1½ inches between centers. Referring to Figure 1, the wire which leads from the terminal P of the electron tube socket is cut at some convenient place Q and the two ends thus formed connected to the extra binding posts. The method followed in making these connections does, of course, correspond with the style of wiring used in the complete electron tube detector unit. The connection X, from one terminal of the condenser C^1, is also removed and a longer wire connected from this terminal to the other side of the point Q where the wire was cut. The base is arranged so that the three remaining sides and a hinged cover may be added without changing the relative positions of the binding posts. Under each of the four corners of the base B, rubber or wood feet or risers are fastened to protect the binding post heads and wiring on the under side of the base.

The upright panel. (See A, Figures 1 and 2.) The panel A is any kind of wood about 4½ inches by 5 inches by ⅜ inch thick. In Figure 2 a back view of the panel is shown which brings the two holes for the telephone receiver binding posts in the lower left-hand corner. If the panel is viewed from the front these two holes will be at the lower right-hand corner. It is desirable that this board present a good appearance, as it is the front panel. Four holes are drilled in the panel A, one for the bolt which fastens the panel to the brace (see L, Figure 1), two for the telephone receiver binding posts L and M (Figures 1 and 5) and one for the shaft of the filament rheostat R^1 (see Figure 1).

The exact location of the hole for the rheostat shaft is determined from the rheostat itself. It is drilled so that the rheostat will occupy as low a position as possible, allowing room enough to do the necessary wiring.

The electron tube. (See E, Figure 5.) The electron detector tube is a commercially available type. An electron tube is sometimes called a vacuum tube or audion.

The electron tube socket. (See S, Figures 1, 5, and 6.) The electron tube socket is of commercial design.

The grid leak and grid condenser. (See R and C, Figures 1, 3, 5, and 6.) The grid leak and grid condenser may be purchased together or separately or they may be constructed. If one expects to use a detector type of electron tube (sometimes called "soft" or "gas" tube) it is recommended that these two parts be purchased with the tube, care being taken to select the proper values of resistance and capacity for the grid leak and the grid condenser, as specified by the manufacturer of the tube purchased. The resistance of the grid leak will usually be between 1 and 5 megohms (1,000,000 and 5,000,000 ohms) and the capacity of the grid condenser will be about 0.0003 of a microfarad (300 micro-microfarads). If an amplifier type of electron tube (sometimes called a "hard" tube) is used, the resistance of the grid leak may generally be anywhere within the resistance limits specified above and the same size of grid condenser used as mentioned above. Experimental grid leaks may be made for such electron tube detectors. This is only suggested for its educational feature. If the two-stage audio-frequency amplifier is used also, it will be difficult to make a grid leak that will work satisfactorily. Such an experimental grid leak may be made from a piece of fiber about 3/8 inch wide, 1½ inches long and from 1/32 to 1/8 inch thick. Two 1/8-inch holes are drilled along the center line of the piece, about an inch apart. A line is drawn between the two holes, using India or drawing ink. Contact with the ink line may be made by the use of two brass (6-32 or 8-32) machine screws about ½ inch long and each equipped with one nut and two washers. The machine screws are put through the holes in the ends of the fiber strip with one washer on each side of the fiber strip. A small piece of tinfoil may be rolled up and wound around each machine screw between the fiber and the washer so that the tinfoil pad will make contact with the ink line. When the nuts are tightened down, the tin-foil pads will flatten out and form a contact between the

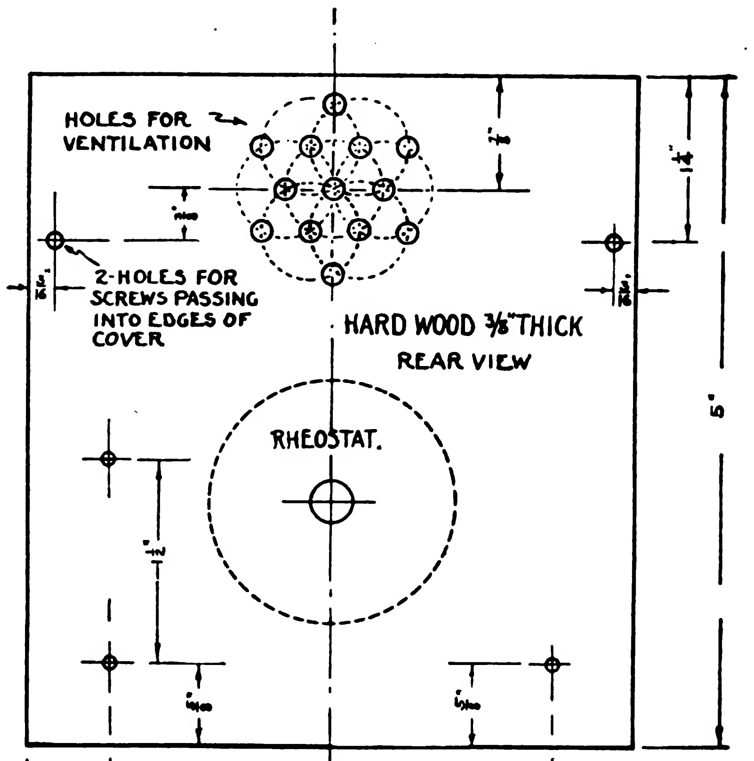

FIGURE 2

This diagram illustrates in detail how to bore the holes in the upright panel "A."

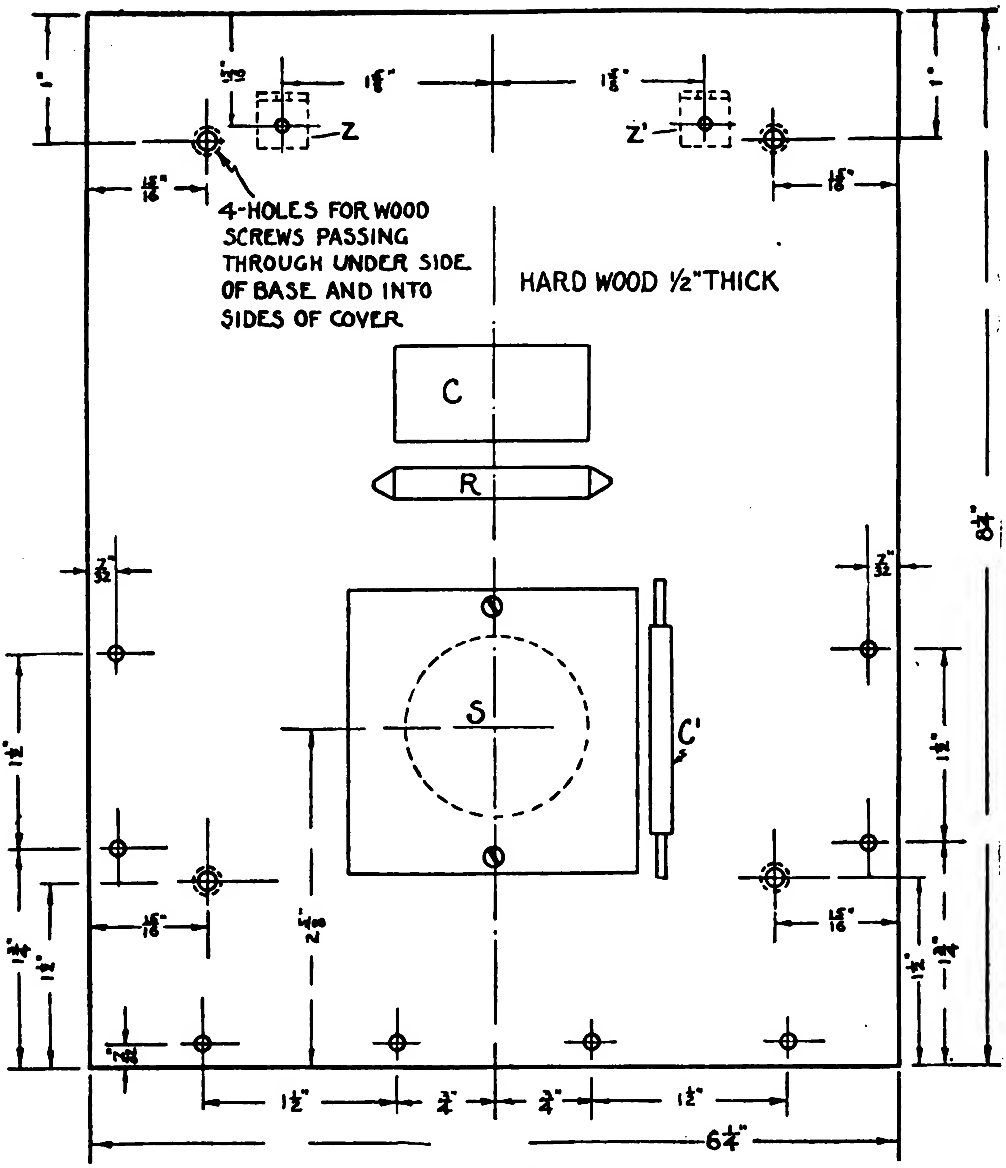

FIGURE 3
A plan view of the baseboard "B"; it indicates where the parts used should be placed and tells the amateur builder where to drill the holes for the binding posts and other parts.

brass washers and the ends of the ink line. Since the ink line makes a partial electrical conductor of high resistance, the thickness and width of the ink line will determine the resistance of the grid leak to a great extent. The value of resistance may be decreased by inking the line over several times, until the electron tube detector works best.

The by-pass condenser. (See C¹, Figures 1, 3, and 6.) This is any small-sized fixed condenser with a capacity of from 0.0003 to 0.0015 of a microfarad (300 to 1500 micro-microfarads) which may be purchased.

The binding posts. (See Figures 1 and 6.) The binding posts used on the base may be 6-32 or 8-32 brass machine screws each equipped with two nuts and two washers, if regular binding posts are not available. The telephone receiver binding posts, L and M (Figure 5), should be of the set-screw type

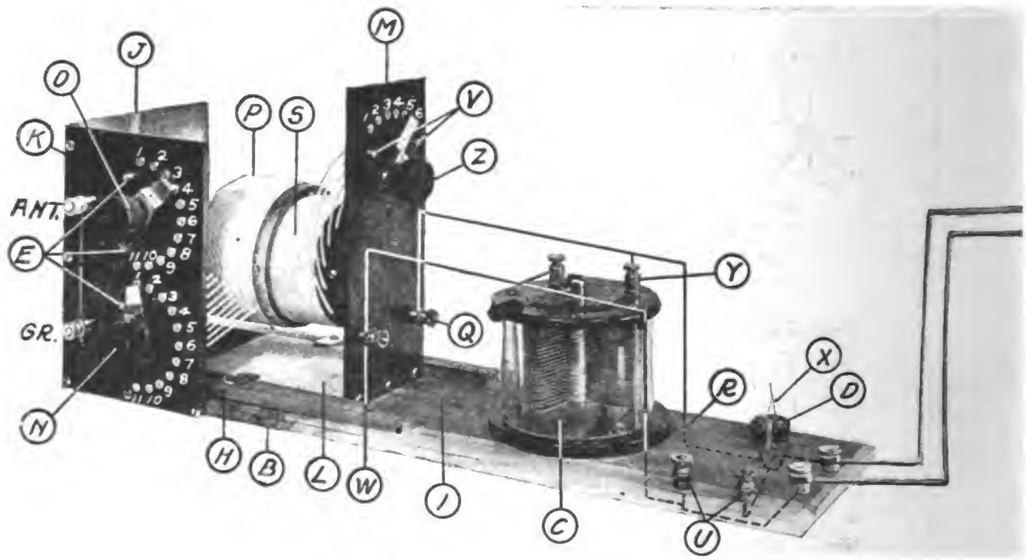

FIGURE 4

This shows how the two additional binding posts are connected to the set described in our July issue, with the two wires connecting it with the vacuum tube detector shown in Figure 5.

to admit the tips of the telephone receiver cords.

The filament rheostat. (See R', Figure 1.) As has been previously stated, the filament rheostat may be constructed but no details are furnished. If the rheostat is purchased, it is desirable to select one designed for panel mounting as well as one that has a neat-appearing knob and pointer. The rheostat should have a resistance of about seven ohms and a current-carrying capacity of about 1½ amperes.

Accessories. The accessory batteries are commercial articles. The purchaser of a storage battery for lighting the filaments should get full instructions from the dealer for testing and recharging the battery. The dry "B" battery usually used for the plate circuit can not be recharged. The normal life of a battery of reliable manufacture is about six months. Storage batteries for use as "B" batteries are available. The first cost is greater than that of dry batteries, but they may be recharged.

Assembly and Wiring

Wood finish. It is essential in electron tube sets that the wood be protected from moisture. While the wood base and panel may be treated with paraffine it is found more satisfactory to dry the wood first and then stain and varnish it, using a good varnish, preferably an insulating varnish. Shellac is not recommended. It is difficult to give definite suggestions concerning drying and staining of wood. Wood may be put in a warm oven for an hour or so to insure more or less complete drying. A lamp-black or carbon pigment stain is not used ordinarily on such radio parts, since it is better to avoid the use of such. The stain and varnish are thoroughly dried before the apparatus is mounted on the wood baseboard and panel.

The baseboard. (See B, Figures 1 and 5.) The eight brass machine screws or binding posts are put in the holes already drilled in the baseboard. If machine screws were to be used the heads would be put on the under side of the baseboard with a brass washer between the head and the baseboard. A brass washer and two nuts are then fastened to each screw on the upper side of the baseboard, with the washer next to the baseboard. The tube socket S, the grid condenser C, the grid leak R and the by-pass condenser C' are next screwed to the baseboard. (Certain types of condensers will be held in position by the wiring only.) The exact location of these parts cannot be stated because the several types of parts commercially available will vary somewhat in dimensions. One can get a very good idea of the relative positions of the several parts from Figures 1, 3, and 6. The tube socket S is mounted so that the two terminals marked G and P (Figure 1)are nearest the upright panel. Blocks Y and Y' are put under the socket S so that the four terminals of the socket do not touch the wood baseboard. This is done by cutting off two round wood blocks just long enough to raise the socket terminals clear of the base, and mounting them so that the screws which hold the socket to the baseboard will pass through holes in the centers of the blocks. After the socket S, grid condenser C, grid leak R and by-pass condenser C' are mounted the parts are wired up. No. 14 bare tinned copper wire is used in wiring. This makes the connections stiff and self-supporting. This wire

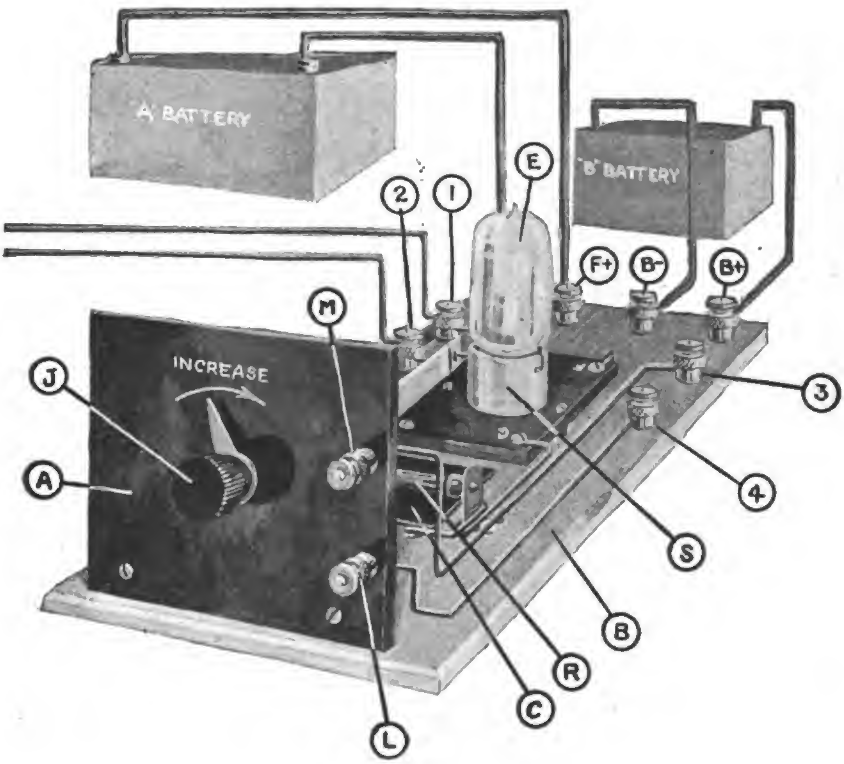

FIGURE 5

The vacuum tube control panel connected up with the necessary "A" and "B" batteries, as they are used to increase the receiving range of the set shown in Figure 4 opposite. This control panel (containing the vacuum tube detector) is merely substituted for the crystal detector that is ordinarily used with the set on the page facing.

is ordinarily furnished in rolls. The wire should be straightened before it is used. It can be straightened by clamping or otherwise fastening one end solidly and pulling on the other end just hard enough to stretch the wire slightly. It is also a good plan in wiring such sets to have all wires run as directly as possible, neatly, and all bends made at right angles. When a wire is attached to a binding post, a loop or eye is formed on the end of the wire and the wire at the eye flattened with a hammer. This gives more contact surface. Special lugs may also be soldered to the ends of the wire before the connection is made. A small hole is drilled through the baseboard just back of each of the tube socket terminals marked F (see Figure 1). A short piece of wire is fastened to the right-hand socket terminal marked F and is then led through the small hole in the baseboard to the under side of the baseboard. The same wire is led to the binding post F and fastened between the machine screw head and washer underneath the baseboard. The same wire is further led to the binding post marked B and fastened between the machine screw head and washer underneath the baseboard. All wires which are run on the under side of the baseboard are shown by dotted lines. A short piece of wire is soldered to the wire leading from the right-hand socket terminal marked F, just above the baseboard and led to the "input" binding post No. 1 and fastened between the washer and the first nut. This wire is shown as a solid line which means it is on the upper side of the baseboard. The wires do not touch the wood boards except at the terminals and where the wires pass through holes in the baseboard. The wires may all be raised more or less to accomplish this. The two terminals of the grid condenser C are connected to the two terminals of the grid leak R as shown in Figure 1. A wire is soldered at V and led to the input binding post No. 2. This wire is kept quite close to the baseboard. Another wire is soldered at V^1 and led to the tube socket terminal marked G. The remainder of the wiring is left until the upright panel is assembled and fastened to the baseboard. Notes on soldering are given later.

The upright panel. (See A, Figures 1, 2 and 5.) The filament rheostat R^1 is mounted on the upright panel A so that the two terminals will be in a convenient position for wiring. Two binding posts of set-screw type, L and M. (Figures 1 and 5), are inserted in their proper holes, and the upright panel mounted in posi-

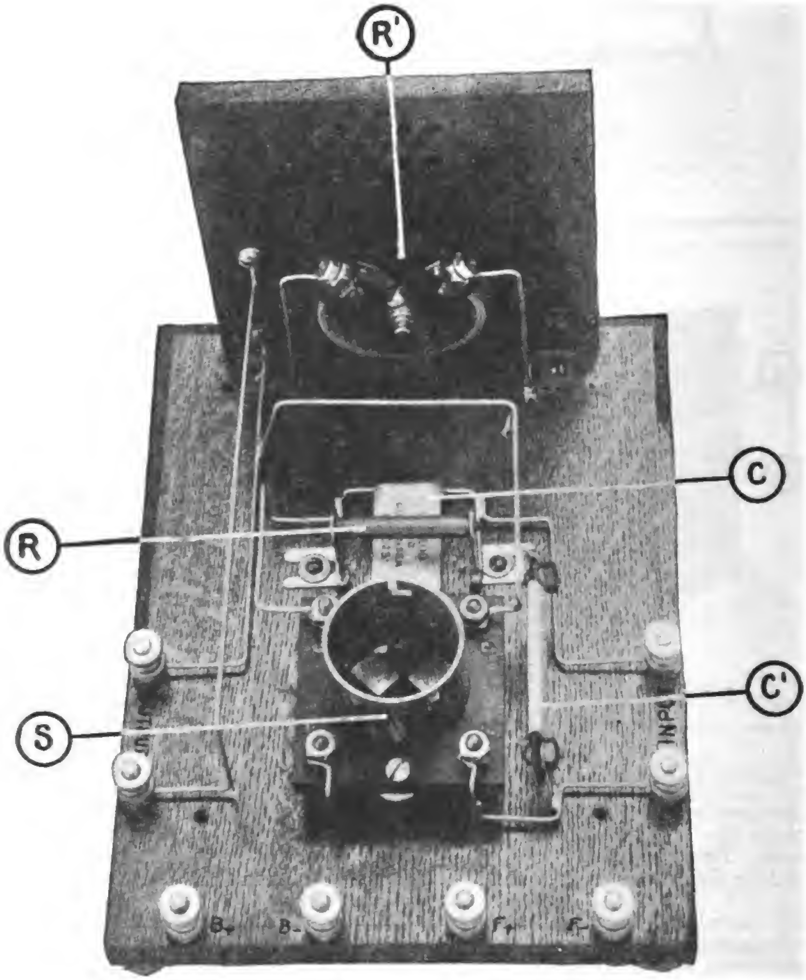

FIGURE 6
The completed instrument, ready to be connected to your tuner. Note the neat way in which the connecting wires are arranged.

tion by bolting it to the two brass angle pieces (Z and Z^1) shown in Figures 1, 2 and 6. One of the telephone receiver binding posts, L, serves as a bolt. Two small holes are drilled through the baseboard near the two terminals of the filament rheostat R^1. A wire is run from the "output" binding post marked 4 (Figure 1) along the upper side of the baseboard to the back of the telephone receiver binding post marked L. A wire is fastened to the tube socket binding post marked P and thence led to the back of the telephone receiver binding post marked L, or else soldered to a convenient place on the wire leading from binding post L. These wires are shown in Figure 1. A wire is run from the binding post marked 3 to the back of the telephone receiver binding post marked M and also a wire from B+ to binding post No. 3, underneath the baseboard. One of the terminals of the by-pass condenser C^1 is connected at the point X and the other terminal of the condenser is connected at the point X^1. The method of making these connections depends to some extent on the particular type of fixed condenser which is used. If the condenser be provided with flexible leads one of them is soldered at the point X and the other is likewise connected at the point X^1. If the condenser is provided with lugs, connections are made by bending the wires into the proper shape and soldering thereto. A wire is run from the filament rheostat binding post marked W through the hole in the baseboard and thence along the under-side of the baseboard to the binding post marked F. This wire is shown in Figure 1 by a dotted line. Likewise a wire is run from the rheostat binding post T and connected to the left-hand binding post marked F. This completes the assembling and wiring of the electron tube detector unit.

Directions for Operating

Connections. It has already been stated that better results are obtained if the two-circuit tuner described in POPULAR RADIO for July is used with the electron tube detector. However, the single-circuit tuner described in the May issue may be used or the electron tube detector may be connected to any tuner not already supplied with an electron tube detector.

If the single-circuit tuner is used with this electron tube detector, two more binding posts are added in the back right-hand corner and wired to the two rotating knobs on that set. Such wiring will not disturb the set for use as a crystal detector receiving set.

If the two-circuit tuner is used with this electron tube detector the arrangement of the parts is similar to that shown in Figures 4 and 5. Connections between the secondary of the coupler and the terminals of the variable condenser are the same as described in the July issue. Two more binding posts are added at the right-hand edge of the baseboard supporting the variable condenser and crystal detector. (See Figure 4.) The dotted lines clearly indicate the new wiring connections.

The antenna and ground wires are connected as described in the May issue. The two new binding posts placed on the old set are connected with the two binding posts marked 1 and 2 on the electron tube detector set, as shown in Figures 4 and 5. The telephone receivers are connected to the binding posts L and M as shown in Figure 5. The red (positive +) wire of the "B" battery is attached to the electron tube detector binding post marked B+ and the black (negative —) wire to the binding post marked B—. An insulated flexible copper wire is run from the red (positive +) terminal of the 6-volt "A" storage battery to binding post marked F+ (Figure 5) and a similar wire from the black (negative —) terminal of the "A" battery to the binding post marked F—.

Operation. The filament rheostat knob J (Figure 5), is turned to the extreme left and the electron tube E inserted in the electron tube socket S. The filament rheostat knob is then turned to the right until the electron tube filament becomes lighted, the brilliancy depending upon the type of electron tube used. When one of the telephone receiver terminals is removed from its binding post and again touched to the post, a sharp "click" in the telephone receivers will be an approximate indication that the circuit is in working condition. If the test buzzer as described in the May issue is available, it may be attached (as described) to the tuner binding post marked "ground" and then the rheostat adjusted until the sound in the telephone receivers is the loudest. The reader should bear in mind that the electron tube detector unit is merely substituted for the crystal detector and the tuning of the receiving circuit is the same as described in our May and July numbers. When signals from a desired transmitting station are heard as loud as possible by tuning, the intensity may sometimes be improved by adjusting the knob on the filament rheostat so as to increase or decrease the filament current (current from the "A" battery). The knob is kept in the position of minimum filament current without reducing the strength of the incoming signals.

If a detector type of electron tube be used, the voltage of the "B" battery is changed until the greatest signal intensity is obtained. This necessitates the use of a tapped "B" battery.

The operator must not expect too much of the apparatus at the first trial. Even assuming that he has had experience with crystal detectors, some difficulty may be experienced in getting the electron tube to operate. In this case he should first ascertain if the various parts of the complete receiving equipment are properly connected; or again, it may be found that some of the connections to the electron tube detector unit are improperly made. Special care should be taken to see that the "A" and "B" batteries are connected to the proper terminals of the electron tube detector unit. After a little experience the operator will find the electron tube to be much more positive in adjustment than the crystal detector.

Notes on Soldering

It has been stated above that certain connections were soldered. In fact, one could well advise that all connections about a radio circuit be soldered, but soldered correctly. There are some general hints that may be given, but judgment and experience are essential. The soldering copper must be clean and the tip well coated with solder. If the tip of the soldering copper is not bright, it should be filed clean. It is then heated, care being taken that the tip is not directly in the flame. After the copper is hot (but not red hot), it is dipped in the soldering flux or paste, and the copper tip coated with solder. The wires are cleaned where the soldering is to be done, using fine sandpaper; then a small amount of soldering flux or paste is applied at the joint and the wires to be soldered are tinned or coated with solder before they are joined. After the wires are tinned they are soldered together, using just enough solder to make the joint solid. The joint should not be jarred while the solder is still soft; to do so weakens the joint and gives the solder a dull appearance. A good soldered joint will be smooth and bright. All excess soldering flux or paste should be cleaned off. Gasoline or alcohol will assist in cleaning off the paste. This last point is sometimes overlooked and the excess flux often causes the copper wires to corrode.

The Approximate Cost of Parts

The list on page 170 includes the cost of parts of the electron tube detector unit and the "A" and "B" batteries. It does not include the cost of the telephone receivers or of any of the other equipment used to make up the complete receiving outfit, inasmuch as these details have been given in the May and July issues of POPULAR RADIO.

It is suggested that a pair of 2,000 or 3,000 ohm head phones of standard make be used in connection with the completed set.

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Will Radio Reform Our Politicians?

What Will Our Congressmen and Senators Say and How Will They Say It When Their Speeches Are Broadcast From the Capital and All the United States Can "Listen In"?

By HARRY A. MOUNT

AN austere member of the United States Senate objected because one of his colleagues used a naval radio station to broadcast a political speech. Government property, he says, should not be used for private political purposes.

This is all very well, argues the opposition, but so long as Congressmen enjoy the franking privilege, why not give them the freedom of the government radio stations?

"Under the law," says the New York *Herald,* "any Senator or Representative may use the mails without limit and without cost to himself for broadcasting speeches that have appeared in the Congressional Record. A Senator has burdened the mails with as many as a million copies of a speech. The letter carriers are annually bowed down with 20,000,000 copies of speeches. What may disturb Congress is not the use of Government radio but whether the party in power will grab the official radio for its own speeches in the important last weeks of a campaign."

One solution of this perplexing problem at once suggests itself: why not build a radio station atop the Capitol, assign it a wavelength and set it to broadcasting the whole proceedings of the Senate and House of Representatives? The venture might even be undertaken as an economy measure; it has its practical features. For instance:

Twenty million speeches, if each carried a two-cent stamp, would cost $400,000 in cash. If they were sent in franked envelopes the cost to Uncle Sam would not be considerably less. To this charge must be added the cost of printing and preparing for mailing. At least we may be sure that if the money now spent on franking were spent on maintaining a

radio station at the Capitol, the results would be a thousand times more far-reaching and effective.

And that brings up another aspect of the influence of the radio on politics; if the proceedings of the United States Senate were broadcast by wireless, what effect would this method of publicity have on the deliberations of that august body?

If a Senator knew he were talking not just to a little group of partisans, each as intent as himself on playing politics "as she is played". . . .

If he knew he were addressing also more voters than there were at that moment in his whole district. . . .

If he knew that enough men and women to turn the tide of the next election in his own district were listening to his every word. . . .

If he knew that more people in Ohio heard him than he could address personally if he made a lecture tour of that State. . . .

What would be the result?

Some day we may be able to "tune-in" on Congress, but whether or not that comes to pass, we are certainly going to have politics by radio from now on. And the effect, on the whole, may be gauged by what changes in the conduct of the Senate we might expect, if the whole Nation "listened in" on its deliberations. It will be interesting to watch the effect on politics of the radiophone.

Although the first widely popular use of the radiophone was in broadcasting the results of a political election—that was in 1920 when the East Pittsburgh

© Keystone View Co.

COLD LOGIC WILL DRIVE OUT THE OLD-SCHOOL ORATORY

Gestures and platform tricks are lost on the radio audience. The political candidate —in this case Gifford Pinchot—must depend for his effects upon sound argument and authoritative data.

Station KDKA was used for this purpose —only limited political use has been made of radio since.

In October, 1921, in Pittsburgh, when the offices of mayor, coroner, sheriff and other local officials were open, the radiophone played a very important part. Every candidate, regardless of party, was given an equal opportunity to speak from KDKA. Most of them took advantage of the opportunity. The experiment was so successful that in the last senatorial and gubernatorial elections in Pennsylvania this same station broadcast speeches by all of the leading aspirants.

In both cases the time allotted each candidate was equal, and it was understood that the speeches would be an announcement of opportunities and promises to constituents as to service if the candidate speaking were elected. It is fortunate, in this case, that the station is controlled by a disinterested party. Equal opportunities might not have been afforded by a station controlled by a newspaper or a political organization.

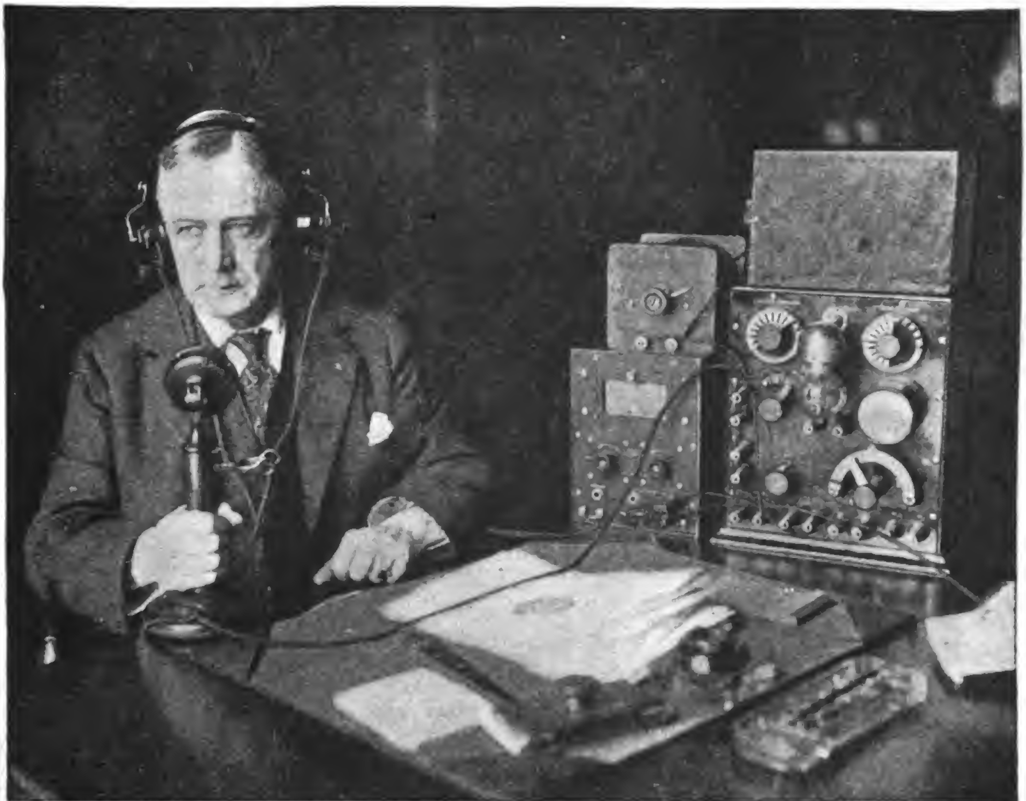
A somewhat more limited use of radio was made in New York in the 1921 municipal campaign when Mayor Hylan and some others of the candidates spoke from one of the local broadcasting stations. But the event had not been widely announced and only those wireless enthusiasts who happened to "pick up" the speech heard it.

The first real test of the value of radio in politics will come, no doubt, in the presidential campaign of 1924. No one can predict with certainty just what will happen, but no doubt the leading candidates will make wide use of the radiophone. Many of our political leaders al-

Pacific & Atlantic

THERE WILL BE NO ALIBI FOR THE CAMPAIGNER-BY-RADIO

Promises made will be heard by voters generally—not by special groups whose favor is courted. Newspaper reporters cannot be charged with "misquoting" a candidate. This picture shows Representative Alice Robertson of Oklahoma addressing her constituents.



International

HE STARTED SOMETHING WHEN HE SPOKE OVER THIS RADIOPHONE

When Senator New spoke to his constituents in Indiana last spring by means of the Anacostia radio station maintained by the Navy he opened up the question as to whether or not government radio stations should be used for political purposes, and if so, under what conditions.

ready have made short addresses by radio and they are fully alive to its possibilities. The list of notables who have talked from a single great broadcasting station include President Harding, Secretary of Commerce Hoover, Secretary of Labor Davis, Secretary of War Weeks, William Jennings Bryan, Theodore Roosevelt, Jr., Governor Sproul of Pennsylvania, Governor Allen of Kansas, and Mayor Key of Atlanta.

At this writing a conservative estimate places the number of wireless receiving stations at 800,000. Last spring equipment was sold just as fast as it could be manufactured. In fact the demand from the larger cities could not be met and little had been done toward introducing radio into the rural districts. Careful investigation has shown that for every receiving station there are four or more head phones so that the whole family may listen in. The present radio audience may therefore number between 2,000,000 and 3,000,000 persons. Further estimates place the possible radio audience of 1924 at not less than 20,000,000.

There has never been a means heretofore, in spite of all the wonders of the telephone and telegraph and the great modern press system, whereby so many persons could be reached so cheaply, so easily, and so directly. Politicians are not going to overlook that fact. They will make the fullest possible use of radio in future elections.

International

THE "SPELLBINDER" OF TODAY IS FORSAKING "THE STUMP" FOR THE TRANSMITTER

For one reason because he can vastly extend the range of his influence; instead of reaching merely hundreds he can reach tens of thousands—as Governor Sproul of Pennsylvania (pictured above) has discovered.

And that brings up the question of what the fullest possible use will be.

It is obvious that if each party or faction sets up its own radio and begins broadcasting its particular brand of propaganda there will be a great deal of confusion from which no great profit may be expected. So long as a man's audience was limited to the number of persons who could get within hearing distance of him the principle of the freedom of speech could be applied in its broadest possible meaning. While he could find someone to listen to him, he could talk as long and as loud and as much as he liked. But when the size of an audience increases until a speaker may have more hearers than there are people in the cities of New York, Philadelphia, Chicago and San Francisco combined, and as only one man at a time can address that audience effectively, it is evident that some sort of an agreement will have to be reached between the various groups.

It would seem an ideal situation if control of the great broadcasting stations should remain in the hands of disinterested parties, and if the government-owned radio should be continued chiefly for the purpose of broadcasting such serviceable information as time and weather reports, market reports, storm warnings, and the like. Likewise, it would seem something of a calamity to this great radio audience, as well as to the politicians themselves, if each party attempts to broadcast its own propaganda, or if any party attempts to monopolize any one of

the great broadcasting agencies. This is a problem which no doubt will adjust itself in time, but, no matter what final solution is reached, the effect upon political methods is bound to be far-reaching.

Consider, for instance, the matter of election promises. It has always been a temptation to political speakers to temper their promises according to the audience they are addressing. If they happened to be talking to an audience of union laboring men they were quite likely to extol the dignity of labor and the strength of union, and to promise that if elected union labor would have a sympathetic friend in office. If, on the other hand, the audience happened to be composed of the members of a country club, the address very likely would take quite a different tone. But if the same speaker were to address a vast invisible radio audience of hundreds of thousands or millions of persons from every walk of life (with no chance to claim the reporters had misquoted him), any promises made would probably be carefully considered and faithfully observed after election.

And not only would the substance of his address be changed, but his very manner of speaking probably would have to change to meet the mechanical conditions of radio transmission.

It has been found by repeated experience that highflown oratory is not effective by radio. Much better transmission qualities are obtained by speaking in a quiet, evenly modulated voice. Extemporaneous talks have proven equally disastrous. Speakers have found it very hard to address extemporaneously an audience which they cannot see and which cannot see them. There are pauses which become very painful and embarrassing. For this reason most radio speakers now read carefully prepared papers, conscious that they must impress their hearers by the thought they present, rather than by any oratorical effects or by the charm of personality. It seems quite plausible, then, that as radio becomes more widely used and more effective in campaigning, we may see the ascendency of quite a new type of politician—a hard thinker who knows his subject thoroughly and speaks with quiet authority, as opposed to the bombastic type of present-day politician.

Presidential candidates will find themselves addressing large numbers, too, of a class of voters whom they have had to neglect in the past. These are the small town and country dwellers who are going to relieve the loneliness of isolated existence by snatching out of the ether, with equal facility with their city brothers and sisters, the very voices and personalities of the great.

Many of those who have given thought to the future usefulness of the wireless believe it will find its chief usefulness in the thousands of homes far from the great centers of population to which the affairs of government, the art and the music of the big cities, the marts of trade, are now rather vague and distant realities. It is true that only a few aerials are at work now over the homes of country dwellers, but no vivid imagination is required to foresee the day, and that soon, when every farm house will have its wireless receiving station. The farmers—especially those who live in distant and out-of-the-way places—are going to be brought into closer communion with state, national and world affairs through the radiophone.

It has long been a criticism of the republican form of government that so many citizens fail to record their judgment by voting, ofttimes making it possible for a well-organized minority to carry an election. No doubt the wireless phone will help to correct that condition. An intelligent interest in government will be stimulated through lectures by competent authorities. As a matter of fact, one of the broadcasting stations has already inaugurated such a series. Before an important election there will be, no doubt, speakers who will emphasize the importance of voting and who will give instructions as to how to cast a ballot.

Students of politics agree that this government of ours is still in the experi-

mental stage. So far the experiment has been so successful that it appears the whole world is taking us for a model.

There have been popular governments before this; but always they have grown to a point where the will of great bodies of people was hard to record, or being recorded, was misinterpreted, or again deliberately perverted by those in power. Ancient Greece had a form of popular government but it became a dictatorship of the cities because only in the cities was it possible to get enough people together to reach a popular decision. Rome also began her greatness with a popular form of government, but the actual number of people who had a voice in her government was limited to those who could crowd into the Forum. Even most of these heard imperfectly what the orators told them and understood even less; hence it was easy for politicians to sway their decisions by conventional and studied dramatic inflection and gesticulation.

The modern system of communication and the newspapers have remedied to a great extent these weaknesses. We have lately seen some startling demonstrations of the power of public opinion to guide the agencies of government. But our popular government is on a grander scale than has ever before been attempted. The number of voters has only lately been doubled by the enfranchisement of women. We need, more than ever before, the enlightening influence of such an agency of publicity as the radiophone promises to be.

The radio will tend to purify politics because it will bring the public into closer contact with its political leaders, and will tend to eliminate those superficial qualities of the old-time spellbinder for the obvious reason that those qualities will not carry over the radio—whereas his facts and his logic and his promises will.

Pacific & Atlantic

WILL RADIO SOUND THE KNELL OF "SECRET SESSIONS"?

When President Harding recently addressed the Chamber of Commerce in Washington his voice was broadcast throughout the East. Some day the deliberations of Congress—and perhaps of the Cabinet—will be heard by millions.

TRICKS—

With High Frequency Electric Current

How the Amateur May Give Spectacular but Harmless Demonstrations of the Peculiar Qualities of that Form of Electricity that Is Used in Radio

By
LEONARD R. CROW

TO the layman, demonstrations of high-frequency electric currents, such as are employed in radio, have an interest that is not lessened by the element of apparent danger with which they are attended. Some of these experiments are spectacular; to a peculiar degree they combine entertainment with instruction. The fact that many of these demonstrations can be easily staged as "tricks" give them an added value to the repertoire of both the amateur and professional entertainer.

Most of our readers will understand what is meant by an alternating current of electricity—a current which changes its direction of flow a certain number of times a second. Commercial currents, which light our homes, run our small power motors and revolve our electric fans, may change their direction of flow between one hundred and two hundred times a second. In such cases the frequency or cycles a second are one-half the number of alternations, as a cycle consists of two alternations.

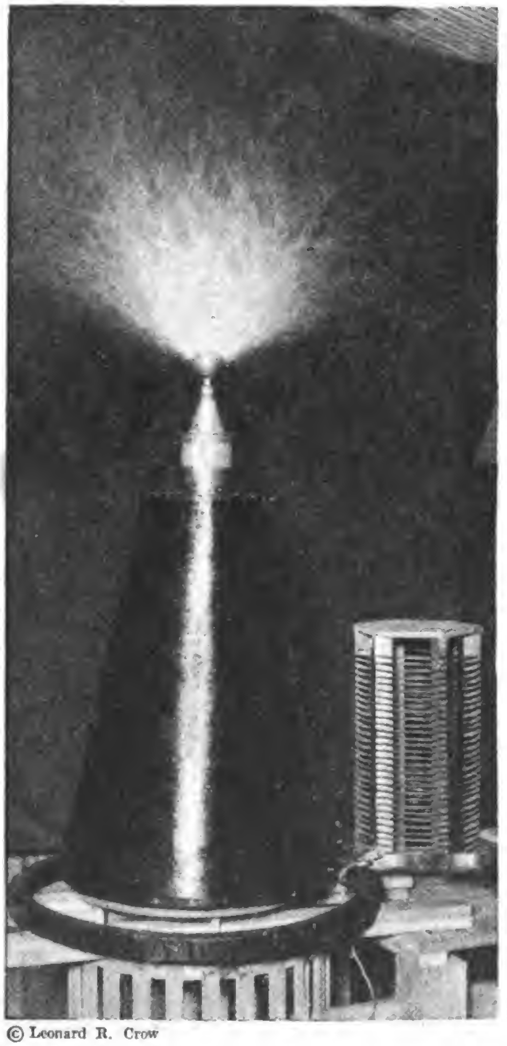
Such currents of low frequency possess certain characteristics which make them dangerous to the human body at pressures of 200 or 300 volts; in many cases lower potentials have produced disastrous results. The low potential, low frequency currents are dangerous when only a small fraction of an ampere is forced through the body, causing contraction of the muscles and a "shock" which is often fatal.

"SWALLOWING" 80,000 VOLTS

This voltage—which punctures a solid oak board an inch thick and sets it on fire—can be taken through the human body without discomfort—provided the frequency ranges above 30,000 cycles a second.

However, if we take this low frequency current—for instance, 60 cycles—with its dangerous and destructive characteristics, and by the use of certain appar-

atus increase its frequency, or number of alternations a second, until the frequency is raised many thousands of cycles a second, we change the characteristics of such a current completely. The current then ceases to be painful or dangerous when passed through the human body; and by increasing the potential it can be made to jump across a gap several feet in length, producing a crashing violet flame almost as harmless as the foods we eat. When such currents pass through our bodies we no longer experience shocks, but instead a pleasing sensation of mild warmth is produced, which has been said to have a beneficial effect upon the body.



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A THREATENING DISPLAY OF FIRE

This snarling and snapping bundle of violet-colored sparks is entirely harmless, however; it is caused merely by discharging into the air a high frequency, high potential current.

When such a current of electrical energy is allowed to discharge through or into the air, the discharges assume the shape of hundreds of snarling, writhing, hissing flames of fire. But threatening as these flames appear, they are not dangerous to the body, as one would suppose. In the apparatus shown on this page, for example, I employed 1,800 watts of electricity. This same electric power at commercial frequencies would not begin to produce a spectacular display, but it would be thousands of times more dangerous to the human body.

If a coil consisting of five or six turns of heavy wire or ribbon is suspended in the air several inches above a high frequency electrical current of even moderately high potential, a current is induced in this secondary coil sufficient in voltage and amperage to light a 110-volt lamp, as shown in the picture on page 188.

With electricity at high pressures and at high frequencies, electrical energies may be passed into the human body sufficient in intensity and strength to produce arcs that give great light and heat. When this oscillating energy is transmitted into the body, passing through a plate of glass in which a 60-watt standard 110-volt lamp is lighted to incandescence, it appears to the eye that these currents actually pass through the glass. However, the current does not pass through the glass as an electric current, but rather in the form of electrostatic charges; the glass, after passing this heavy current, does not exhibit any physical change in the condition of its surface.

One of the most interesting features of this phenomenon is that the physiological effects of even extremely high frequency, high potential currents are found to be so very small that the current from a secondary terminal of the

© Leonard R. Crow

"MAKING AND MENDING" HOLES IN GLASS WITH CURRENT

The electricity transmitted into the body through a glass plate (lighting an incandescent globe on the other side) appears to pierce the glass. Actually, however, it passes in the form of electrostatic energy and leaves no mark whatever on the plate.

oscillation transformer can be taken through the body without any discomfort or inconvenience to the recipient (except perhaps a small burn produced by the discharge when taken directly upon the bare skin).

One should never attempt to take large currents directly into or upon the body without first receiving the current through some form of metal electrode. For instance, when one takes currents into the hand, the current should be taken from the machine through a metal rod which is held in the palm of the hand. In this manner a large contact area is offered to the flow of current, and thus, distributing the received currents over a large area, reduces the piercing or burning sensation to a minimum.

In taking currents into the mouth a common tablespoon may be used to advantage, as this affords a good contact with the tongue.

The peculiar effects of these currents may be due to several reasons—either to a different distribution through the body or to the tissues acting as condensers; although in the case of large high frequency coils that carry larger amounts of energy, the harmlessness would indicate that the cause might be due to other conditions not yet determined. One theory is that our nerves, fast as they are, are still too slow to respond to currents so rapidly oscillating. If the current that passes through the body in one direction affects the nerves, the current as it reverses, neutralizes the effect of the first half cycle before the nerve had time to respond. Another theory is that high frequency currents pass only on the outer surface of a conductor, never pene-

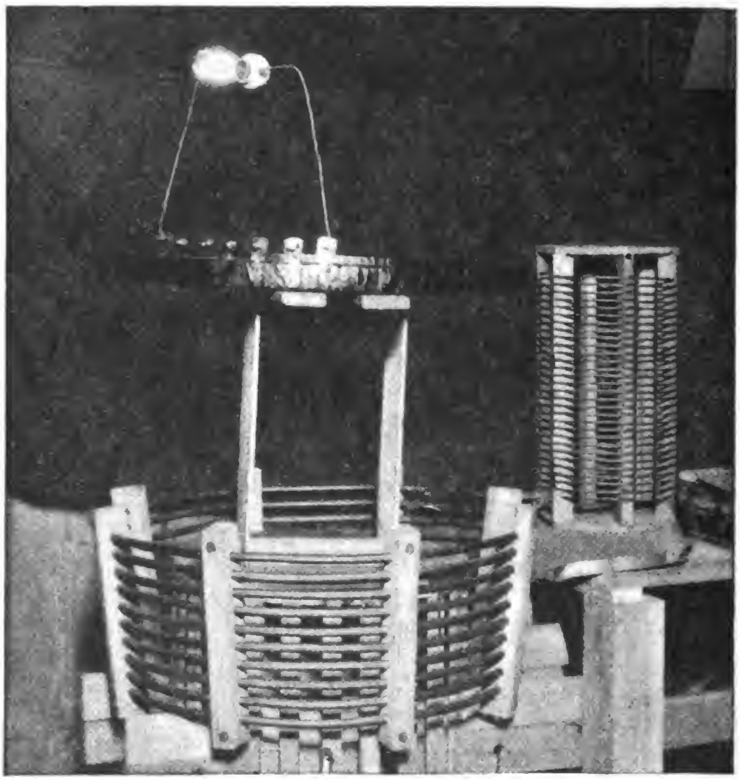
trating the body far enough to affect the nerves.

When the frequency and strength of currents flowing through the primary of a high frequency coil are varied, many different forms of secondary discharges are produced—thin, thread-like discharges, powerful, flaming discharges, and various forms of brush and streaming discharges. A high frequency current discharge, when properly produced, gives the appearance of a purple flame of burning gas under great pressure, emitting quantities of ozone.

The striking peculiarity of high frequency discharges, brushes and streamers, is the ease with which they pass through thick insulation.

However, this current is not confined to the use of spectacular and mystifying phenomena. Such high frequency, high potential currents, when properly applied to the body, are said to improve general nutrition and act as a tonic in building up the body; curing many diseases by stimulating the circulation.

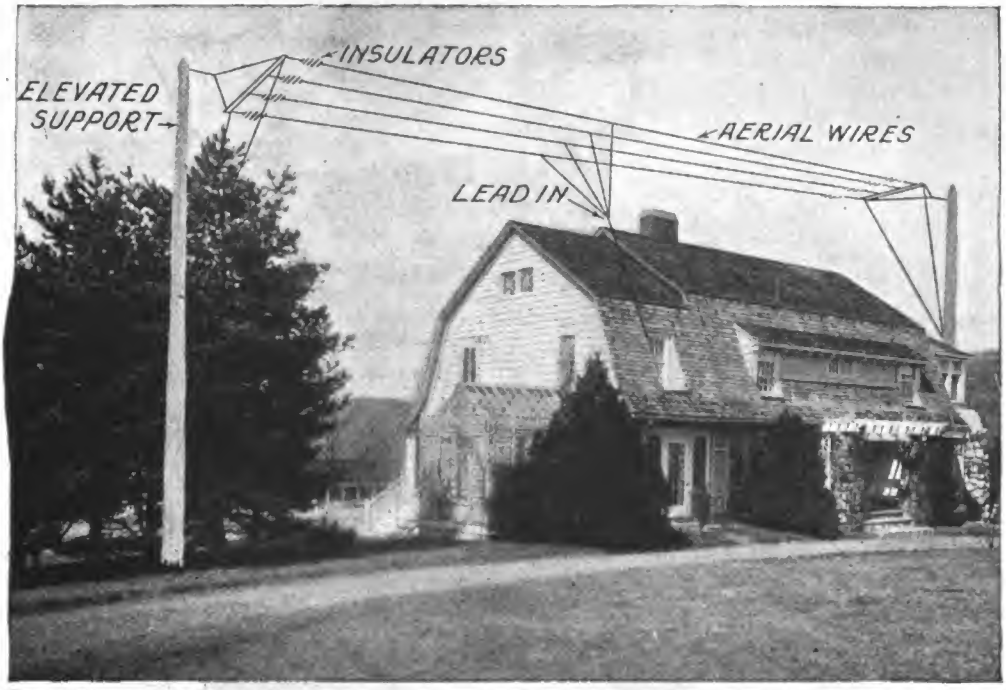
Through the production of high frequency electricity we are capable of seeing the otherwise invisible. The X-ray, one of the greatest discoveries of man, is possible through the use of high frequency waves. Today man is capable of transmitting his very thoughts across great distances with incredible speed and accuracy without the aid of any visible transmitting medium. Were it not for this mysterious rapidly vibrating radio frequency electricity, wireless telegraphy and telephony would still be a thing unknown.



© Leonard B. Crow

LIGHTING AN INCANDESCENT LAMP "WITHOUT A CONNECTION"

The energy for lighting the standard 110-volt globe is sent through the air. This current is induced in a coil consisting of five or six turns of copper wire suspended above a primary coil in which high frequency current is flowing.



From a diagram made for POPULAR RADIO

The Most Popular Transmitting Aerial

THE T-TYPE OF ANTENNA

The Second of a Series of Short Articles on the Various Types of Antennae and Their Uses

By DAVID LAY

THE inductance of an antenna depends, roughly, on the total of the length of the ground lead and the length of wire from the set to the farthest tip of the antenna. In the case of the inverted L type of antenna this would include the length of the ground lead, the length of the lead-in, and the length of the flat top. This would give a certain wavelength which would correspond to the "natural period" of the antenna.

Suppose, for example, that we should be so located that we could not put up the ordinary 100-foot antenna as used for broadcasting reception, but could put up a longer one, say 150 or 200 feet long. Ordinarily the wavelength or natural period of this antenna would be too high.

If we put up a T antenna of this extra length, (that is, if we should divide the flat top in two, with the lead-in in the center as shown in the diagram on this page), we will have the same over-all length from the ground to the farthest tip of the antenna as in the shorter L type of antenna. This will give us an antenna with approximately the same inductance but twice the capacity. Obviously this antenna would have a lower wavelength than an L type antenna of the same length and would be ideal for transmitting, while at the same time it would be suitable for receiving.

The T type antenna will provide slightly better reception characteristics in the directions in which the two ends of the antenna point, but it will receive well from any direction.

From a photograph made for POPULAR RADIO

THE AUTHOR SHOWS HOW TO DO IT

In order to insure accuracy in his description of the way to tune a standard single-circuit regenerative receiver, Mr. Hogan actually performed the work in his laboratory—as these illustrations demonstrate. He especially warns the amateur against allowing the tube to oscillate, which causes interference to others in the neighborhood.

The Right and Wrong Ways *of* Adjusting *the* Regenerative Receiver

By JOHN V. L. HOGAN

ALTHOUGH it is not at all difficult to handle a simple regenerative receiver so as to secure from it really remarkable gains in radio reception, there exists a widespread impression that great skill is necessary for its proper manipulation. This is perhaps due to two prime causes:

First, because many poorly designed regenerators, which are almost impossible to control properly, have been made or sold and are in use;

Second, because well planned and built receivers are frequently supplied with incomplete or even misleading instructions for operation and so puzzle unskilled users.

Radio phenomena, understandable enough when the fundamental reasoning underlying them is explained, are indeed baffling to the uninstructed novice; when one adds to the simple tuning effects the interesting and varied actions which the feed-back circuits produce, it is something of a wonder that in the tremendous recent growth of radio receiving more trouble has not been experienced.

In order to fix our ideas about the

operation of the Armstrong feed-back, let us concentrate upon a simple circuit arrangement which is now in wide use and which is capable of giving excellent results with only simple adjustments.

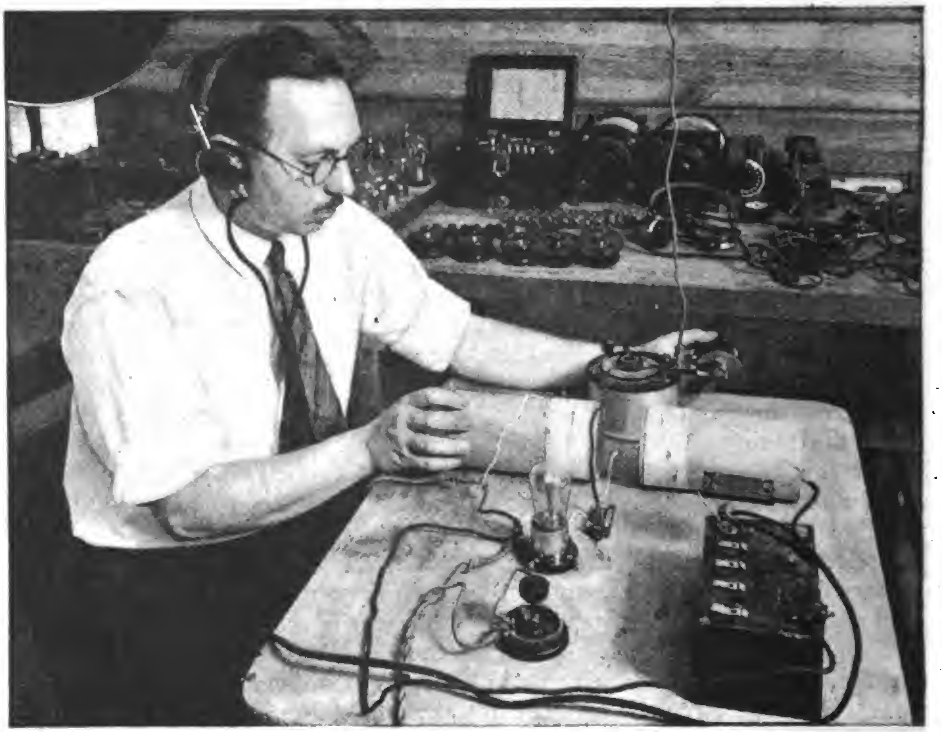
Figure 1 is a diagrammatic representation of this layout, which may be called the "single-tuned circuit" with inductive feed-back. It shows a simple aerial-to-ground circuit including a variable tuning condenser and a tuning coil which is preferably adjustable in steps and to which is inductively (and variably) coupled another coil. The terminals of the tuning coil are connected to the detector tube grid, through condenser C_1 and leak resistance R_1, and to the negative side of the filament. The filament circuit includes the usual six-volt storage battery and a finely adjustable rheostat R_2 for controlling the temperature or brilliancy of the filament cathode and consequently its electronic emission. The plate circuit is completed through the second or feed-back coil above mentioned (frequently called the "tickler" coil), the telephone receivers and the "B" battery of about 20 volts potential—the telephones being shunted by a by-pass condenser C_2.

For best results on the 360 meter wave length, which is common in radio broadcasting, the aerial capacitance should be not greater than about 0.0005 microfarad, and its natural wavelength less than 220 meters or so. These conditions will be met by a single wire antenna from 120 to 150 feet long (including the down-lead to the instruments) and from 40 to 60 feet above the earth. The tuning condenser should be variable over at least the range from about 0.0001 microfarad minimum to 0.0007 maximum capacitance. The tuning coil should have an inductance in the general neighborhood of 50 to 100 microhenries, the exact value (which may in some cases be outside these limits) being determined largely by the particular antenna used. A coil of fifty turns of No. 22 B & S double cotton-covered magnet wire wound on a cylinder of 3½ inches diameter and provided with taps at 20, 30, 40 and 45 turns will give good results in most cases. A "hard" vacuum tube like the VT-1 or UV-201 should be used for the detector, as its vastly increased stability is ordinarily to be preferred over the delicately adjusted higher sensitiveness of a gassy tube in regenerative circuits. A grid condenser C_1 of about 0.0003 microfarad, grid leak of 1 megohm and by-pass condenser C_2 of 0.005 microfarad will usually give good results. The filament rheostat will be of about six ohms total resistance.

This leaves only the feed-back coil for consideration; a winding identical with that suggested for the tuning coil will work well under most conditions. The two coils should of course be arranged to be easily moved with respect to each other, so that the amount of feed-back coupling can be varied conveniently. In working with wavelengths as short as 360 meters and capacitance values of the order of 0.0005 microfarad and less, changes in tuning are frequently produced by the additional capacitance introduced when one's hand is brought near the circuit to adjust it. In an experimental outfit these bothersome effects can be avoided by fitting the tuning condenser and the coupling with insulating control handles some twelve inches in length, which will permit adjustment without close approach of the operator's hand. When a set is built up in panel form, a grounded copper shield plate between the control knobs and the instruments aids in securing compactness.

So much for the constructional fundamentals of a simple but effective regenerator.

It will be noted that there are only four variable elements in the entire system, namely; (1) the tuning condenser; (2) the tuning coil; (3) the coupling controlling the amount of feed-back, and (4) the filament rheostat. As the last-named item is not critical and as both the tuning controls produce the same



From a photograph made for POPULAR RADIO

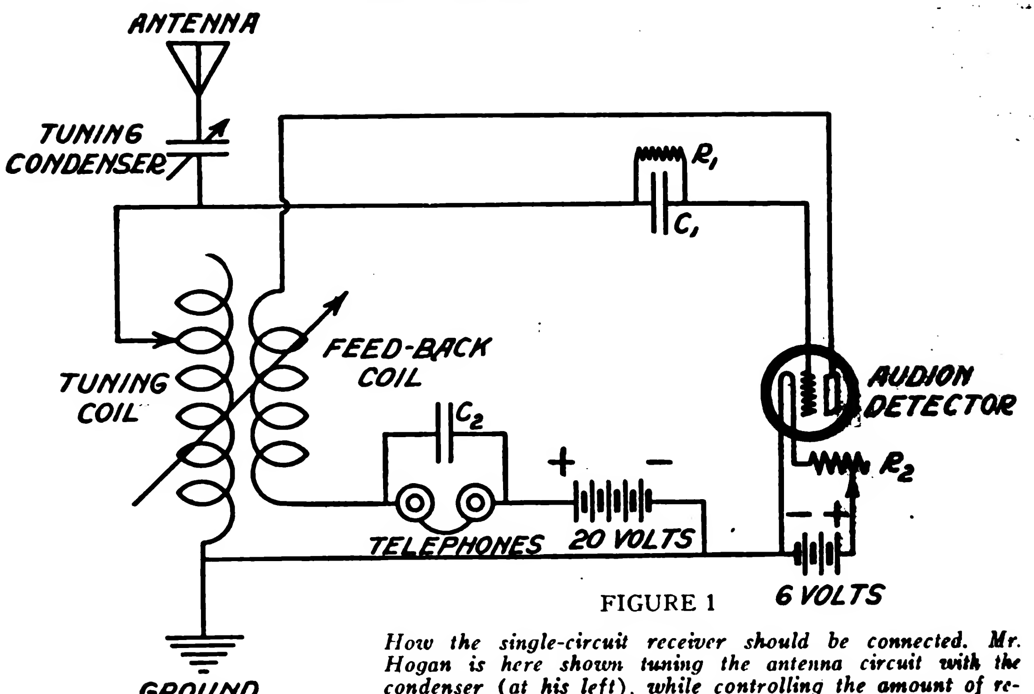


FIGURE 1

How the single-circuit receiver should be connected. Mr. Hogan is here shown tuning the antenna circuit with the condenser (at his left), while controlling the amount of regeneration by moving the tickler coil nearer or farther away from the tuning coil.

general effect, it is fair to say that only two elements (the tuning condenser and the feed-back coupling) need be adjusted in the normal use of this outfit. The tuning condenser will ordinarily be of the semi-circular multiple plate type having a total capacitance of about 0.001 microfarad; for easy adjustment in short wave working it is convenient to provide in addition a so-called "vernier" condenser, which has only two or three plates and which, when connected in parallel to the main tuning condenser, produces a change of tuned wavelength (for a motion through its entire scale of 180°) equivalent to only three or four degrees of the main condenser. The other adjustment—the feed-back coupling—may be controlled by turning a knob which varies the angular position of the "tickler" coil with respect to the tuning coil, or simply by moving the coils themselves nearer together or farther apart.

If you have purchased a regenerative receiver of the single circuit inductive feed-back type you will have no difficulty in these two adjustments; the handle usually marked "tickler" controls, from maximum to minimum, the amount of regeneration; and the resonant wavelength is varied by means of the "tuner" knob, supplemented, in some of the better instruments, by a closely adjustable condenser called the "vernier," as described above. In setting up an assembled or home-made outfit, however, it is necessary to determine the proper or additive direction of feed-back coupling. To do this, first be sure that the circuit is wired exactly as shown in Figure 1; put into circuit the full 50 turns of each of the two coils, and place them some distance (at least 8 to 12 inches) apart on the operating table. Listening in the telephones, test the detector circuits by turning on the filament to normal brilliancy and making and breaking a connection of the 20-volt plate battery; if everything is all right a strong click will be heard in the telephones at each completion and interruption of the circuit. By varying the tuning condenser it should now be possible to pick up (and tune to maximum strength) some radio telegraph or telephone signals; perhaps it will be necessary, if your aerial is relatively large, to reduce the number of turns used in the tuning coil. If signals can be "tuned in," the proper current direction in the feed-back coil can easily be determined by moving it nearer to the tuning coil, for if the signals increase in strength as the coils approach each other everything is all right. On the other hand, if bringing the two coils nearer together produces a weakening of the signals, either the tuning coil or the tickler coil must be reversed end for end. Once having the relative directions correct, the amount of regeneration is, of course, controllable from minimum to maximum by moving the coils from a relatively widely spaced to a closely adjacent position.

If signals cannot be picked up while the coils are far apart, try varying the tuning condenser as the coupling between the coils is increased, first with one relative direction and then with the other. Radiophone or wireless telegraph messages may be intercepted at some wavelength, with the help of regenerative amplification, so that the proper relation of the coils may be observed. If no signals whatever can be heard at the time the apparatus is being tried out, you will have to rely upon the oscillation test. Listening in the telephones as before, slowly bring the tickler coil near to the tuning coil; as they approach, if the relative directions are correct, you will hear a single "cluck" in the telephones. This marks the point of increased regeneration at which the whole receiver begins to generate radio-frequency oscillations. On moving the coils apart these local oscillations will cease; by increasing the coupling once more a repetition of the "cluck" will be heard, indicating the recommencement of oscillations. If the two coils are wrongly directed with

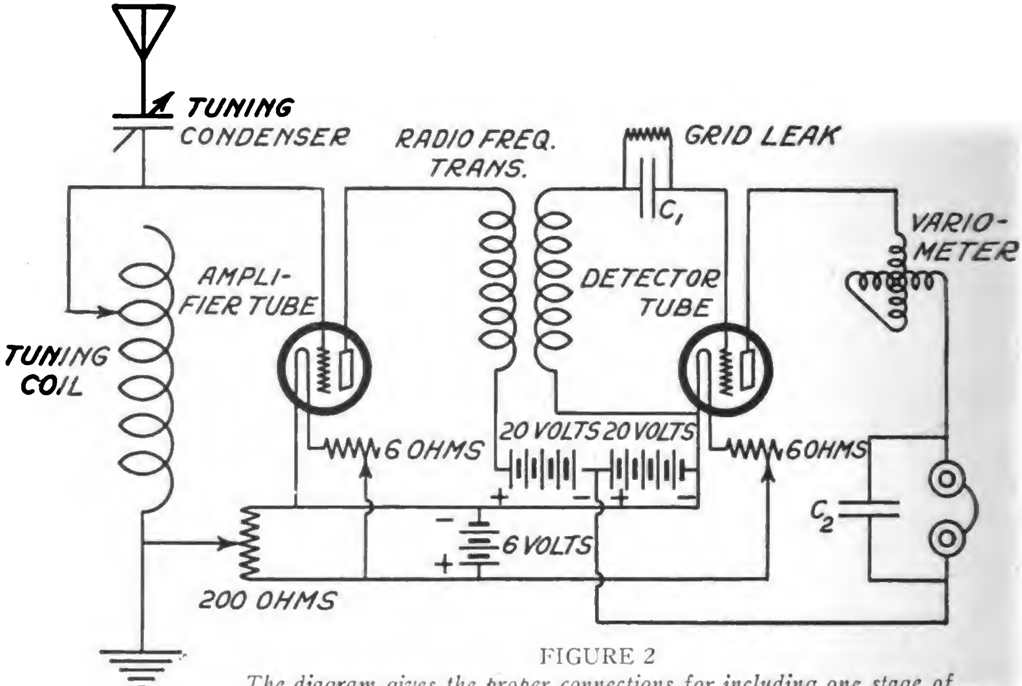


FIGURE 2

The diagram gives the proper connections for including one stage of radio frequency amplification in the regenerative set. By this means the set is prevented from re-radiating high frequency oscillations, which cause so much interference in the hands of inexperienced operators. Static is also reduced by this addition.

respect to each other it will be found either that these oscillations cannot be produced at all or that the two coils must be nearly touching each other in order to do so. The remedy is, as before, to reverse one of the coils. Instead of turning one coil end for end, the wires connecting to it may be transposed.

Now let us look a little more closely at the adjustments necessary to get best results.

The set must be so assembled that the oscillation or "cluck" effect just described can be secured easily at the working wavelengths; when the feed-back coupling is increased to the point where oscillations are generated, their presence can be detected by tapping the grid connection of the detector tube; on each contact of the finger this same characteristic cluck will be heard in the telephones. If your set will not work in this way it is not regenerating properly, and you will not get the best results from it until it is fixed up.

To pick up a signal of unknown wavelength, or one for which the tuning condenser setting is not known, the tickler coupling should be set at a point sufficiently loose (toward the minimum) to prevent the set from oscillating as the condenser knob is swung back and forth throughout its range. If the desired signals are not heard at any point of the condenser scale with the full tuning coil inductance in circuit, change the number of turns and swing the condenser handle again; when the tuning coil is reduced in inductance by cutting out some of its turns, the tickler coil can ordinarily be moved up closer to the tuning coil without causing oscillations to begin.

After you have found the best number of tuning coil turns and the best condenser position for the desired signals, move the tickler coil slowly toward the maximum coupling position; as the coupling is increased nearer and nearer to the point where the receiver starts to generate oscillations, the signals will

grow louder and louder. The tuning condenser should be readjusted slightly as the tickler coupling is increased, for the greater feed-back action makes the circuit more sharply tuned and a very exact setting becomes necessary in order to secure the loudest signals. It is for this final critical adjustment that the vernier condenser is so convenient.

The feed-back coupling cannot be increased indefinitely, for as the point where oscillations begin is closely approached the signals will not only increase in volume, but will show signs of distortion. This is particularly disadvantageous in receiving radiophone speech or music with amplifiers. When the oscillation point is reached or passed, the radio-frequency currents generated in the receiver react with those of the received wave to produce electrical beats which may entirely spoil the character and quality of the signals; hence the feed-back coupling should always remain on the side toward "minimum" from the oscillating point, for receiving radiophone, spark or other modulated wave signals.

There is another good reason, beyond the loss of signal clarity, for always keeping the tickler coupling below the oscillation-generating point; the radio-frequency currents set up in the receiving outfit by circuit reaction pass out of the receiver itself and into the aerial, there radiating electromagnetic waves of the frequency to which the set is tuned. Thus the receiver virtually becomes a continuous-wave transmitting outfit, which, although relatively feeble in power, is capable of creating severe interference for several miles around.

Every time you allow your regenerative receiver to break into the oscillating condition by increasing your tickler coupling too far, you send out radio waves from your antenna. Every time you hear in your telephones the loud heterodyne whistle caused by interaction between the received carrier-wave and the oscillations generated within your outfit, the waves your set radiates are producing similar interference whistles in sensitive receivers near you. Thus you not only spoil your own reception, but also that of your radio neighbors in a zone of several square miles. All of us have heard interference produced in this way and have learned how aggravating it is. As this disturbance is totally unnecessary and nothing more than a demonstration of ignorance or lack of consideration on the part of "transmitting" receiving set users, no one who understands its causes and effects will want to create such interference deliberately.

While there is no hardship in tuning to an unknown telephone or modulated wave while keeping the regenerative receiver slightly below the just-oscillating condition instead of slightly beyond it, sometimes one finds it convenient to pick up a continuous wave by setting the receiver into oscillation and swinging the condenser knob back and forth until the heterodyne whistle is heard. This should never be done at wavelengths near the broadcasting wave of 360 meters; even at other frequencies it may produce bad interference. However, by equipping the receiver with a single radio-frequency amplifier in advance of the detector tube, the local oscillations may be kept almost entirely out of the aerial and this source of interference practically eliminated. Figure 2 shows a circuit arrangement of this kind; further details of it will be given in a future article.

How to Select the Best Coil for Your Set

In the next number—December—Prof. J. H. Morecroft will tell the radio amateur just what the functions of a coil are and how to determine which coil is best suited for the amateur's purpose.

From a photograph made for POPULAR RADIO

"THE AUTHOR WHO ENTERTAINS BY RADIO SHOULD BE PAID"

The problem of collecting fees for the use of copyrighted music that is used on broadcast programs has long been agitating the music publishers. Now the book publishers are wondering how the rights of the literary man can be similarly guarded. Mr. Doran, the eminent book publisher, here tells why and how this may be brought about.

"First Radio Rights" for Authors

A New Development of "Literary Property" That Radio Is Bringing About

By GEORGE H. DORAN

"*UNLESS an author has or can cultivate voice personality, he or she should not attempt to give a radio talk or reading.*"

That is the message that I have sent to all of my authors. I consider it most important. A number of authors have given talks or readings by radio with probably harmful results, owing to poor delivery. They were inaudible.

At best, they did neither themselves nor their publishers good.

By "voice personality" is meant a very definite thing. The vaudeville interests have, I understand, forbidden their artists to give radio talks. I also understand that the loss to radio programs as the result of this restriction is almost negligible.

Why?

Because most vaudeville performers get their effect, after all, only with stage accessories—gesture, facial expression, costumes, background—and (above all), the presence of a large audience, each member of which encourages the others to laugh. Take away all these factors and strip the artist to his voice alone and how many of our popular entertainers can hope for any widespread success?

Apparently those who are first in line for success with the radio audience are those who have mastered the technique

of making phonograph records. They have had to rely upon the voice alone. They have had to possess or develop what I am calling voice personality. On the other hand, this gift probably exists in a number of people. How far it can be acquired I do not know. But obviously it is of primary importance in a talk or reading to a radio audience.

I shall talk frankly to our authors about the matter of appearances on radio programs. I shall caution them not to attempt to give talks or readings unless they are reasonably sure of a clear and audible delivery. That is the first requisite. But more than that will be needed for any widespread success. They must have a theme of interest to great numbers of people; the radio audience is made up of all ages, of all degrees of education and of all conceivable varieties of taste. The appeal must be to the highest common divisor of that taste. It must be the highest appeal that can be made to each and every one of this vast crowd. That is what the author must start with; and what can be accomplished after that remains to be seen, but will depend very largely upon the author himself.

The fundamental situation in regard to radio is unusual. Here we have, already established, an instrumentality for entertaining and instructing a million or more people, all at the same time. These people do not pay a cent for this entertainment or instruction. Until some means is devised for charging an admission fee to the radio program it will be impossible to develop the first class radio artist, the person supremely gifted with voice personality, able to entertain and instruct the million. As soon as a device is hit upon for charging a few cents a night, radio programs will be immensely profitable enterprises. There will then be no question of the development of the radio artist nor of his monetary reward.

Then we shall have advanced to another stage; the authors who can appear successfully on radio programs will be materially enriched from that source and there will undoubtedly arise the question of what I may call "first American radio rights" in literary property.

These will have to be added to existing rights, such as first American serial rights, book rights, second serial rights, dramatic and motion picture rights.

"First American radio rights" in a book would consist of the exclusive right to broadcast throughout America by radio talks or readings the whole or parts of a copyrighted book. It is easy to see that the day will come when simple dramatic short stories and certain novels will be wanted to entertain the radio audience. The day is practically here now when books of instruction are wanted to attract and interest the radio audience.

The copyright law of the United States, at the present time, contains no specific provisions with regard to use of material in connection with radio telephones. However, Section One of the copyright act secures to the person entitled thereto the exclusive right in sub-section *c* "to deliver or authorize delivery of the copyrighted work in public for profit if it be a lecture, sermon, address or similiar production."

Probably that wording is ample to protect the rights of authors in copyrighted literary work when the radio goes on a money-making basis. So far as I know, those in charge of radio programs have shown every care not to use copyrighted material without permission; as the matter now stands, the use of such material is not, directly at least, "for profit," and permission is, by me at any rate, cheerfully granted.

But when the day comes for first American radio rights we shall have such novels, perhaps, as the first-class detective or mystery story, of the type that is provided with exciting climaxes at the end of every one or two chapters, desired for radio use. The reading of the story may easily not be by the author at all, but by somebody with the requisite voice personality. It does not matter.

Westinghouse

A "VOICE PERSONALITY" IS A GIFT THAT ONLY SOME AUTHORS HAVE

An author who reads from his own works must be sure of an audible delivery and he must have a theme of general interest. One of the most popular is Howard Garis, whose "Uncle Wiggly Bed Time Stories" are known to millions.

The point will be that for the use of the book, the author must be properly paid. I do not anticipate the slightest difficulty in fixing what the author shall be paid, tentatively, until the market for first American radio rights shall be established; I merely speak of this by way of normal prevision.

I was much interested by the broad basis upon which Mr. J. W. Hiltman, President of D. Appleton & Company, reasoned in regard to radio. Mr. Hiltman gave it as his emphatic opinion that anything which keeps the family at home is bound to be good for books. He says that people who form the habit of staying at home will, sooner or later, read books. I think so too. I am more interested in how the approach shall be made —in what books they do read or will want to read and in what ones of our books already published or about to be published they can most readily be interested.

I should be willing to undertake, if it could be arranged, an experiment with any of our books to determine what types of books the radio audience likes best. At present, little is known along this line. Almost the only point that has conclusively been proven, through authors' readings given so far, is the immense popularity of bedtime stories for children. This is of an importance to the authors of children's books that it is not easy to exaggerate. But there are endless books in which I foresee a widespread interest, once the radio audience knows about them.

One of our authors, for example, tells in a humorous and sane way about weight

reduction—a subject of no small interest to a very large number. Those whose weight satisfies them can still enjoy the humor of the book. The same author has written a novel of interest to anybody who drives a car, especially if he has taken or contemplates taking a transcontinental trip. The material of which these books are composed is exactly the sort of thing that should interest a radio audience.

During the recent visit of Sir Arthur Conan Doyle to this country, overflowing crowds have come to the halls to hear his lectures on spiritualism. Most of those who came, I don't doubt, did not believe in the possibility of communicating with the dead, but they were interested in what Sir Arthur had to tell. Many thousands heard him; why not a million?

That is what radio ought to mean to books and authors and publishers. It ought to mean a hitherto unrealized possibility in the way of audiences. It ought to mean that through hearing an author talk over the radio telephone on some subject in which he is interested, a man would go out and buy that author's book; or though he heard not the author himself, but someone with the requisite voice personality reading from the author's book, the same result would follow. It is a chance for those who feel that natural personal interest in an author whose works they enjoy to hear his voice or to learn those personal details which are of interest to his readers.

For my part, I see in radio only a valuable instrumentality for furthering the cause of good reading. When the telephone was invented the book publisher proceeded to use it to the feasible extent in furthering the cause of books. When the phonograph was perfected, a chance to link that new instrumentality with the cause of good reading was probably missed—although I hope not finally. Now the radio is here. It is a tremendously multiplied lecturing platform; it is a new and more fascinating phonograph; it is the telephone in a million homes. I shall leave undone nothing that occurs to me to realize to the fullest imaginable extent its powerful aid.

How *to* Make Your Bed Talk *to* You

By S. R. WINTERS

NO longer can the phrase "falling in the arms of Morpheus" be properly used as a symbol of sleep. No longer need one retire attended by the silence of the bed chamber at night. For science has waved its wand and endowed the bed with the gift of speech and of music. In other words, your bed springs may be used as an aerial for the reception of stories, lectures and music transmitted by radio.

Just how this feat may be accomplished has been demonstrated by Mr. H. G. Corcoran of Washington, D. C., who has literally converted his bedroom into a radio station with one unusual feature.

A towering antenna as well as the elaborate fixtures that project from the housetop is eliminated by Mr. Corcoran's innovation. The antenna lead is affixed to the springs of the iron bedstead, and the ground connection is effected through the means of a water-pipe and radiator in the sleeping quarters.

This radio-telephone receiving outfit is of a single-circuit regenerative design. Its source of strength—or electric current, to be exact—is imparted by a 6-volt, 60-ampere battery. Two variometers; two condensers, one with vernier attachment; one detector tube, and one-stage of audio-amplification from two "B" batteries are the operating units which work in harmony to insure the reception of music and vocal speech from near and

distant points. Three pairs of head telephones are connected to the equipment. Vibration sound, to repeat common knowledge, is not barred by walls and the reception is not hindered by the fact that this wireless receiving set is contained within closed quarters. To paraphrase the axiom, "Prison walls do not a prison make," the installation of a radio-telephone receiving equipment does not insure isolation even though one be enclosed securely by stone and mortar.

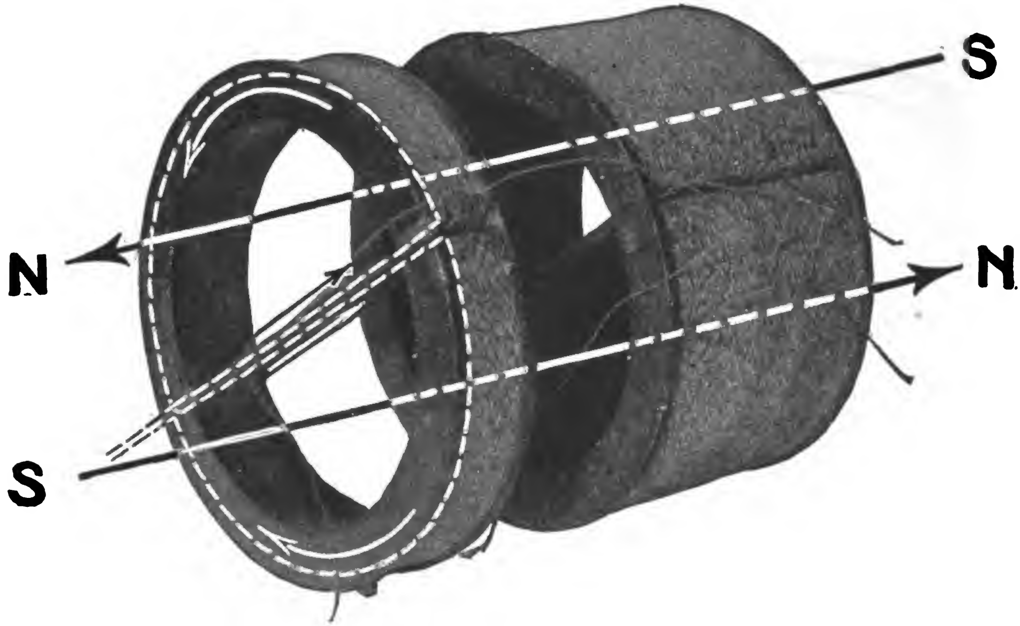
"Now listen, my children, and you shall hear how the elephant got his trunk," may be the introductory sentence to a bed-time story that seeps its way into the room of this Washington citizen who has distorted the heretofore single purpose of the bed-springs. Mr. Corcoran, by a mere twist of one of the knobs on the apparatus illustrated in the photograph, can adjust the receptive "moods" of this outfit to a point of receiving music or messages from Detroit, Springfield, Schenectady or Newark. Radio transmitting stations that are not so far removed as these may occasionally be heard distinctly.

Fans who ransack the ether for its contents may duplicate this unusual procedure and thus contribute to their own pride and satisfaction by having a receiving set that is distinctive. Mr. Corcoran used much pre-war material in building his own outfit. Radio fans who contemplate summer excursions into the woods or fishing trips that will take them far from the city may investigate the desirability of carrying along their bed-springs. This household unit now can serve a two-fold purpose—contribute to the comfort of peaceful sleep, and relieve the monotony of existence when you are alone.

© Harris & Ewing

A NOVEL RECEIVER THAT REALLY WORKS

The apparatus, which consists of a regenerative receiver and amplifiers, gathers energy from the springs in the bed, which thus serve as antennae. Such a set can pick up nearby stations—but a bedspring hardly compares with an outdoor aerial in efficiency.



TWO "FIGURE 8" COILS AS A VARIOCOUPLER

The dotted lines in the photo-diagram show how the winding is made to give the coils a double magnetic field, as shown by the large arrows. Two coils coupled together in the position shown produce a maximum coupling; but if one of them should be revolved on its axis 45 degrees the coupling will be zero, as the fields will neutralize each other.

How to Make a Novel Variocoupler

Another of the Series of Practical Articles That Tell the Novice How to Build His Own Apparatus at Low Cost

By A. HYATT VERRILL

A FORM of variocoupler which seems but little known to amateurs and novices and which is a simple and efficient type, is that built of what are known as "Figure Eight" coils. To make a really good variocoupler with the secondary coil in the form of a rotor is a difficult job. Rotary ticklers in tube form will give results, yet the coupling is never as satisfactory as with a round rotor. But with the Figure Eight type of variocoupler no inside rotor is required, the secondary consisting of a second coil placed at one end of the primary and in the same plane with it and rotating on an axis parallel to that of the large coil.

Owing to its peculiar construction—with the winding going first in one direction and then in another forming a coil with four poles—a wide range of coupling may be secured with a 45 degree rotation of the secondary coil. The result is a tuner which has the qualities and advantages of a variocoupler and at the same time is simple to construct.

To make this coupler you will require a

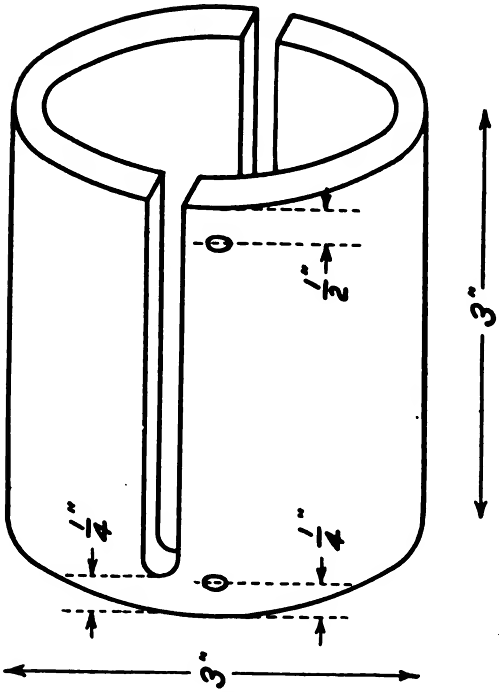


FIGURE 1
The larger tube (for the primary coil) should be made according to the dimensions in the above diagram.

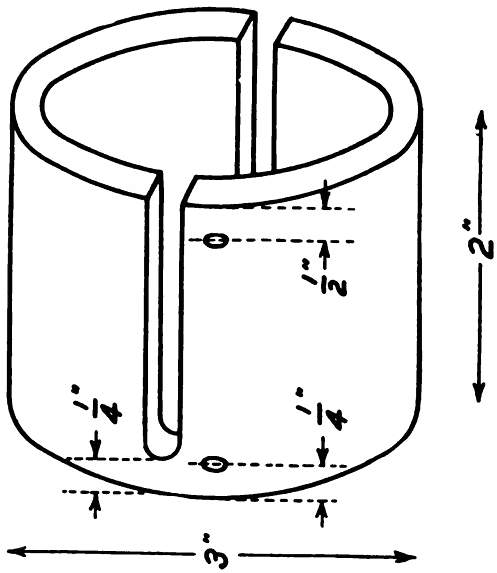


FIGURE 2
The smaller or secondary tube should be made like the larger tube—but with the dimensions here shown.

supply of No. 20 or 22 cotton or silk insulated wire; two formica or composition tubes, both three inches in diameter and one three inches and the other two inches in length. You should also have a ten point switch, two discs of wood of the same diameter as the inside of the tubes, a short section of 1/4 inch brass rod or a long 1/4 inch brass bolt, brass washers, binding posts and nuts.

Commencing with the larger or primary coil, by means of a straight edge, draw a line or scratch marks upon the edges of the tube across the exact centre. This will be easier to do if you draw a line across the centre of one of the wooden discs and then, by placing this in one end of the tube, mark where the ends of the line come on the tube.

Having determined this, draw a line from each of these marks to within one-quarter of an inch of the opposite end of the tube. Keep these lines parallel with the axis of the tube and then, with a hack saw, cut through the tube along these lines. Be careful not to use too much force, but work slowly and easily so as not to break the tube. The result should then be as shown in Figure 1.

Repeat the operation on the small tube, Figure 2.

Now bore a hole near the end of one of the cuts in both tubes and another hole near the cut and half an inch from the other end of the tubes. (Figures 1 and 2.) Run one end of the wire out through the hole that is a quarter inch from the end of the large tube, leaving several inches projecting, secure it in place by sealing wax and proceed to wind on the wire as shown in Figure 3. Starting at the hole where the wire is fastened, take a turn up through the slit, around the half of the tube and through the opposite slit, bringing it across to the first slit near the starting place. Then bring the wire in a turn around the opposite side of the tube from the first as in Figure 4, carry it across the tube through the slit, wind around beside the first turn and thus continue winding first in one direction on

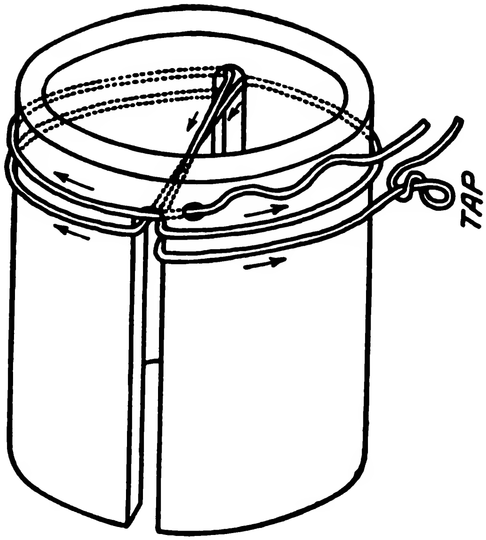


FIGURE 3
How to start the winding of the wire on the primary coil. Compare this diagram with the one on page 201.

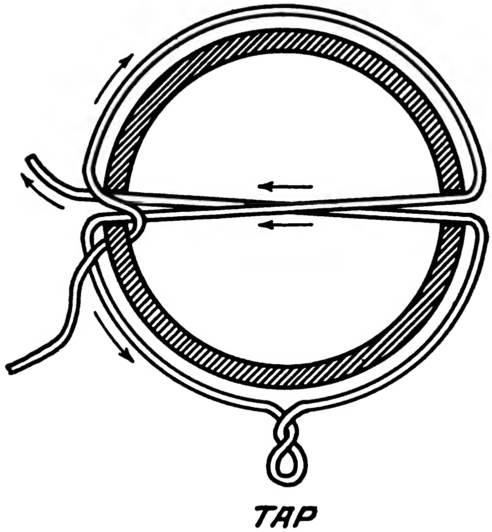


FIGURE 4
How to make a tap. In the winding of a coil, a tap should be made at every ten turns until nine taps are made.

one-half the tube and then in the opposite direction on the other half of the tube, making a series of figure 8's with the winding. When the tenth turn is reached make a tap in the usual manner and continue winding until the twentieth turn on the same side as the first tap is reached, then take another tap.

Go on winding in the same way, taking a tap at every ten turns until ninety turns and nine taps are made. Then pass the wire through the hole near the end of the tube and secure it with sealing wax. Next, fasten one of the wooden discs in this end by means of small brads or screws and secure the disc in whatever way you see fit to a bracket or similar support as shown in Figure 5.

Next start with the smaller tube in exactly the same way, fastening the end of the wire at the hole nearest the tube end and winding on the wire exactly as on the large tube, but without taking any taps. When seventy turns have been taken, fasten the wire in the hole, leaving a fairly long free end.

You must next decide what sort of adjusting device and mounting you are going to use for the coupler. If it is to be mounted on a panel, a bracket on the primary as shown, with the secondary mounted with a shaft running through the panel, is both convenient and neat. In this case, the shaft that bears the knob should be secured to the wooden disc by means of two nuts. Washers soldered to the shaft with loose washers as bearings should be provided or (if preferred) loose washers and cotter pins may be used. It makes little difference which method is employed so long as the coil cannot move out and in and thus vary the distance between it and the primary coil. The accuracy with which the two are fitted together has a great deal of influence upon results, for if the secondary wobbles or varies in its distance from the primary the coupling will be unevenly variable. The whole idea is to keep the tubes and the two windings as close together as possible.

A simple method of mounting is shown in Figure 6, in which both coils are mounted on a panel or base by means of brackets. The shaft used to rotate the tickler should be accurately centered in the wooden disc and the latter should be fitted and fastened securely within the

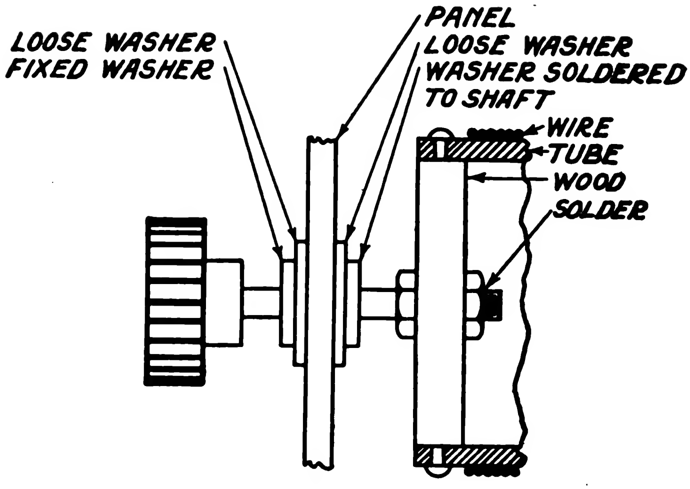


FIGURE 5
How to fasten the rotating secondary coil to the panel, with the control knob attached.

tickler coil by means of small screws driven in through the half-inch bare space left on the tube for the purpose. Do not slight this part of the work, but take just as much care in fitting the wooden ends and fastening them and in mounting the complete coupler as in winding the coil or finishing the cabinet or panel. It is neither good workmanship nor common sense to spend a lot of time and trouble as well as good material in making a coil or any other device and then, either because you are in a hurry to test it or because you get tired of the job and wish to finish it quickly, slight the last part of the work. Many a well-made instrument has been cast aside as worthless just because the maker slighted some little thing near the finish of the job. If you have done careless work it is of little use to try to make up for it by placing the instruments in an elaborate and highly polished mahogany cabinet with engraved dials and Bakelite panel. Remember the old Romans' adage, "The gods see everywhere," and do not think, because your careless work is invisible, that it will "get by." There are no more

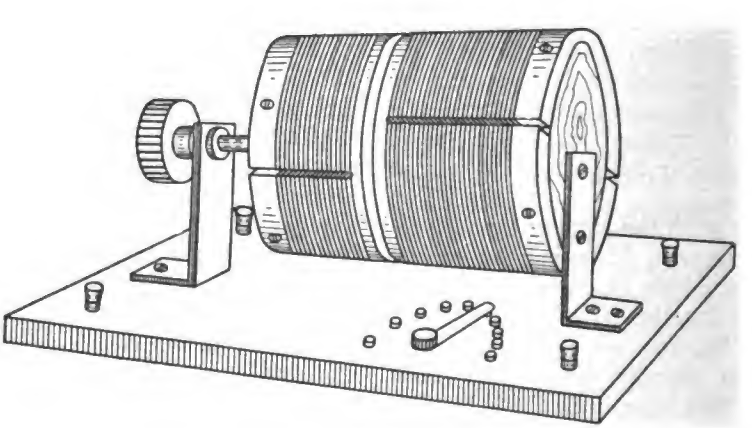


FIGURE 6
A simple method of assembling the variocoupler on a board for experimental use. Be careful not to slight this part of the work.

unsparing inspectors than radio waves; when they enter that beautiful looking cabinet and find poor or careless work inside they will shout the fact aloud to you and to your friends by squeals, buzzes and howls instead of good clear signals.

Figure 7 shows the completed Figure Eight coil variocoupler, the secondary of which may be connected up with a suitable crystal or vacuum tube circuit.

The variocoupler may be mounted on a panel so that the control knob protrudes from the front of the panel; in this case the primary switch and the switch-points should also be mounted likewise, so that the instrument may be placed within the cabinet that contains the other parts of the set.

The best way to tune the secondary circuit is by the use of a variable condenser shunted across the secondary winding, although in some vacuum tube sets a variometer is connected in series with the grid of the tube, and the tuning is accomplished by this means.

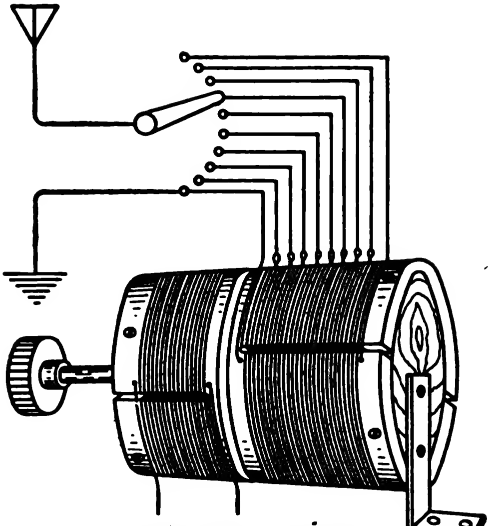


FIGURE 7

The completed Figure Eight Coil Variocoupler, showing how to hook up the primary circuit. The secondary circuit can be connected to any standard crystal or tube circuit.

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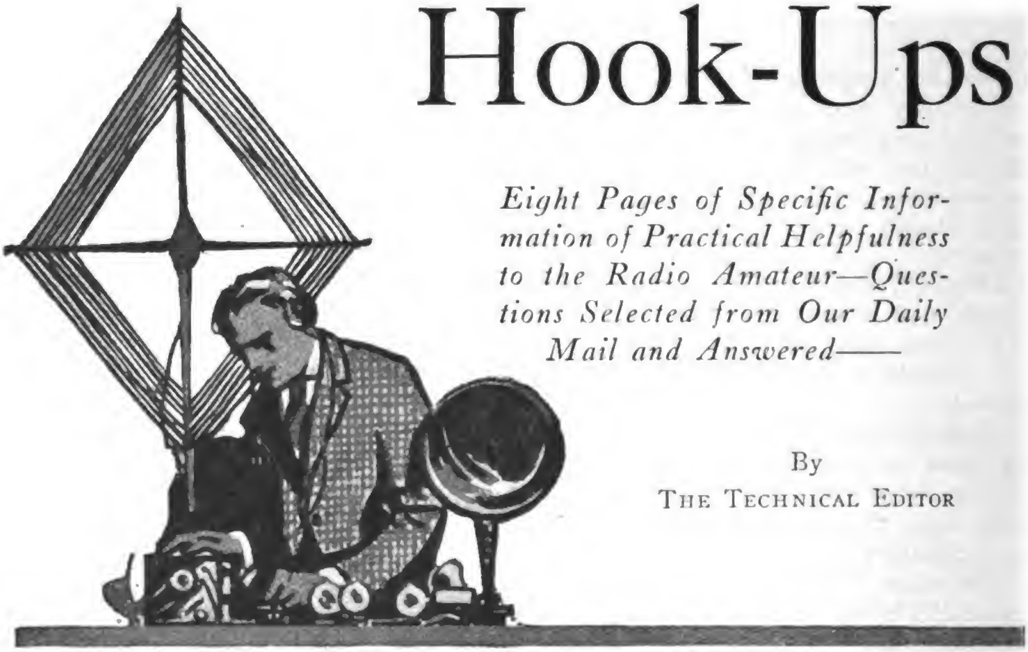
HOW TO INSTALL A RADIO SET ON YOUR MOTOR CAR

Despite the number of fake installations devised for publicity purposes, which have given rise to misconceptions on the subject, the equipping of an automobile with a workable receiving set is entirely practical. The several ways of doing it will be told in the next issue of Popular Radio.



Hook-Ups

Eight Pages of Specific Information of Practical Helpfulness to the Radio Amateur—Questions Selected from Our Daily Mail and Answered——

By
THE TECHNICAL EDITOR

THE information embodied in this feature is ordinarily furnished in the department, ***What Readers Ask,*** which is published regularly in POPULAR RADIO. In order to make this department of greatest help to the beginner, it is possible to publish only those questions and answers which are of the widest application and of most general interest. To insure prompt attention and to help the Technical Editor in handling the large amount of correspondence which the department has developed, our readers are asked to observe the following requests:

1. Confine each letter of inquiry to one specific subject.
2. Enclose a stamped and self-addressed envelope with your inquiry.
3. Do ***not*** ask how far your radio set should receive. To answer this inquiry properly involves a far more intimate knowledge of conditions than it is possible to incorporate in your letter.

The questions that are not of sufficient general interest to warrant publication in this department will be answered personally. Many of these questions are being answered by referring the correspondents to items that have already been printed in these pages. To get the full benefit of this service, therefore, *save your copies of* POPULAR RADIO.

IN answer to the hundreds of requests that have come pouring in on the Technical Editor for additional data on the super-regenerative circuit (described in the September number), the following notes on the super circuit have been prepared. These notes embrace improvements and hints for those who are building or who have built sets from the description of the set that was published in these pages.

First. The method of connecting the loop to the set has been modified so that any sized loop may be used; tuning is accomplished by varying the switch taps of the coil "F" and rotating the condenser "C," which is in series with the loop. See Figure 1, in which the hook-up is given and the method of tapping the "F" coil is clearly shown.

Second. The "C" battery in series with the grid of the second tube has been eliminated, and only two batteries are used, as in the ordinary vacuum tube set, the "A" and "B" batteries.

Third. The tubes recommended for use with this circuit are the Radiotron UV-201 or the Myers audion for the first tube, and a Moorhead amplifier or W. E. "J" tube for the second tube.

Fourth. The circuit shown in Figure 1 may be used with the telephones by tun-

ing out the signals a little so that they will not hurt the ears, or it may be used with a loudspeaker just as it is. The signals with the two tubes should be loud enough to fill a good-sized room using a loop. If the signals are wanted strong enough to fill a large hall, however, a one or two-stage audio frequency amplifier should be added to the set. A one-stage amplifier will produce signals that will be audible over a house, upstairs and downstairs; a two-stage amplifier will make them audible for a quarter of a mile or more, according to the tubes used, the type of loudspeaker employed, and the tuning ability of the operator. The input terminals of the amplifier should be connected to the two leads of the set marked "xx" in Figure 1.

Fifth. If the amateur builder has trouble in getting the set to operate properly after he has checked up all connections and parts, he will do well to try reversing the terminals of the coils "F," "A," and "B" one at a time.

Sixth. When a "saw-tooth" heterodyne (whistling) effect is heard while tuning with the condensers or the variometer, the builder will know that he is getting nearer to success in making his set work properly; when this sound is heard it is merely a case of becoming familiar with the adjustment.

Seventh. An antenna may be used with the set, if the antenna is attached to the loop by means of a clip. The correct turn of wire on the loop to which the outdoor antenna is to be attached will be determined by experiment while tuning. No changes are made in the circuit for using the outdoor antenna, and no ground is used. This will bring in the distant stations louder without increasing the nearby stations.

* * *

QUESTION: In a regenerative type set composed of two variometers, one variocoupler, and a variable condenser, what are the controls that govern the regeneration of the incoming signals? Please tell me, also, the proper method of tuning.

WILLIAM PRESTON

ANSWER: Regeneration is accomplished in this type of set by rotating the plate variometer. We refer you to the article by E. H. Felix in the May issue of POPULAR RADIO, entitled "How to Tune a Regenerative Receiver."

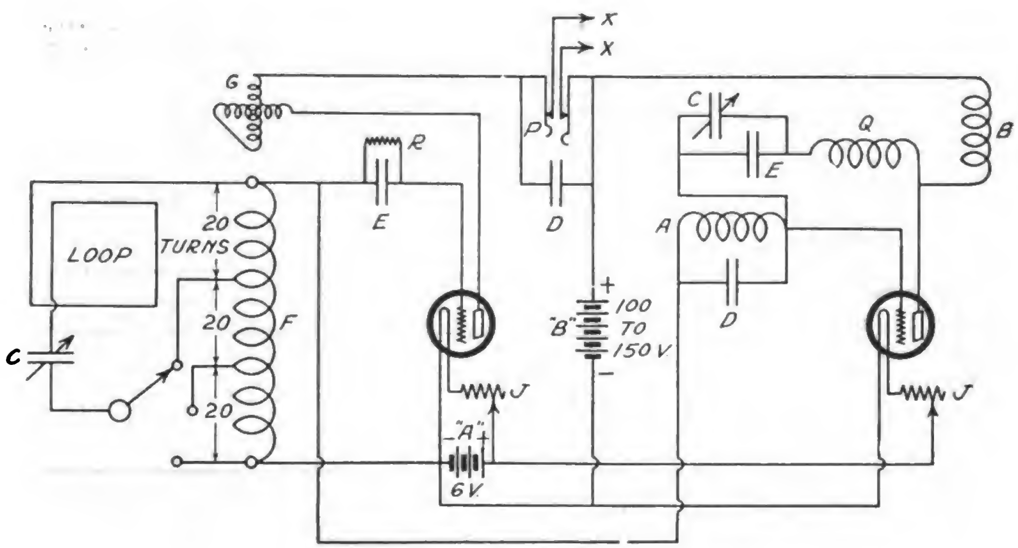


FIGURE 1

The two-tube super-regenerative circuit which has proven so successful. Note that the use of "C" batteries is dispensed with. An audio frequency amplifier may be connected to the two wires marked "XX," and the signals increased to terrific strength.

QUESTION: I have a crystal set with a two-slide tuning coil. Could I use a loop aerial and would it work as well as the horizontal type of aerial?

R. GEMMECKE

ANSWER: A crystal detector is not sufficiently sensitive to use with a loop antenna with any measure of success. We advise you to stick to the outdoor antenna until you decide to install a more sensitive set with some form of radio frequency amplification. You would otherwise obtain no results.

* * *

QUESTION: Would it be possible for me to use one stage of radio frequency with one stage of audio frequency amplification? If so would you please print a circuit using a set of Goodwin untapped spiderweb coils together with said amplification?

J. H. W.

ANSWER: This is possible, and the circuit is shown in Figue 2. L1, L2, L3 are the spiderweb coils, L4 is a single slide tuning coil, C1 and C2 are variable condensers, .001 mfd. capacity, C3 and C4 are fixed condensers, .0005 mfd. capacity, R1 and R2 are resistance potentiometers, 200 ohms, R3 is a grid leak resistance, 1 or 2 megohms, and R4, R5, and R6 are filament rheostats, 6 ohms each. 22½ volts are used on the detector plate and 90 volts are used on both the radio frequency and the audio frequency amplifier plates.

* * *

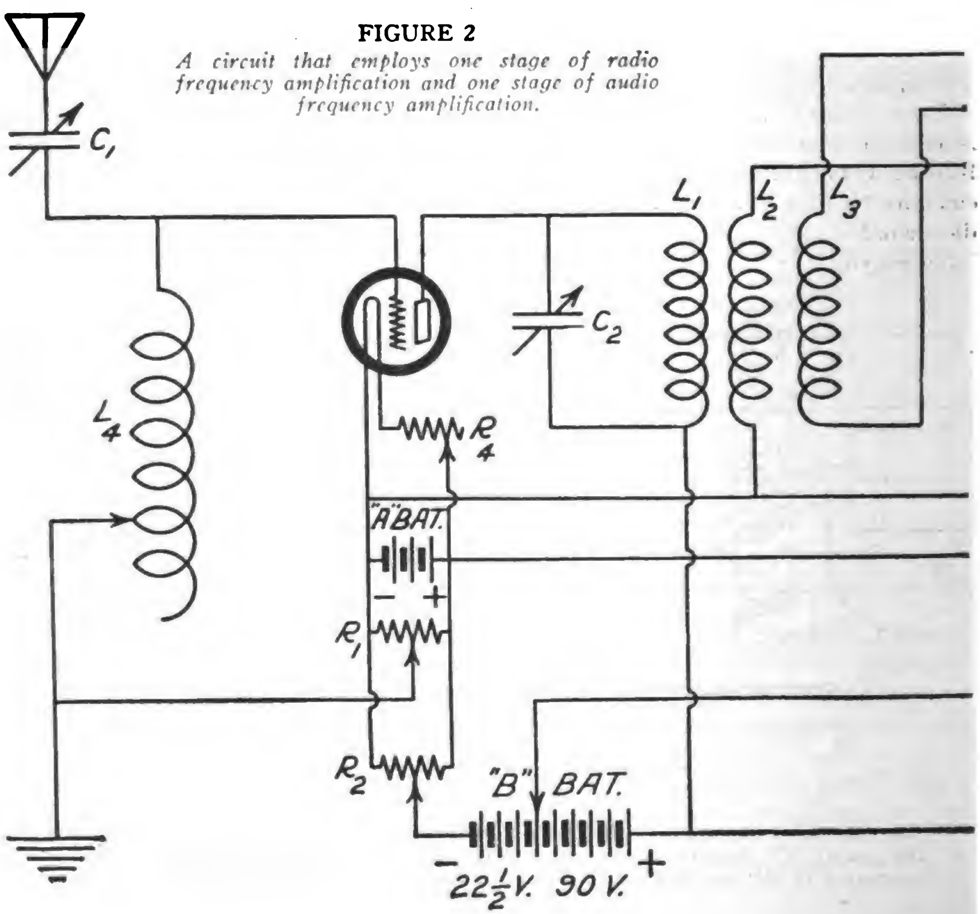
QUESTION: Would it make any difference what size variable condenser I have in the receiving set described in the July issue of POPULAR RADIO, on page 194?

JAMES H. HIND

ANSWER: Any condenser with a capacity value lying between .0005 and .001 mfd. will be suitable, although the larger capacity the condenser has, the higher the wavelength to which the set will be able to tune.

FIGURE 2

A circuit that employs one stage of radio frequency amplification and one stage of audio frequency amplification.



QUESTION: Please inform me if a coil may be tuned with a variable condenser as well as with sliders; I mean the primary coil of a loose coupler.

R. M. B.

ANSWER: The wavelength of an antenna circuit having in it the primary circuit of a loose coupler may be tuned satisfactorily by means of a variable condenser. In fact, if the condenser is used with a series-parallel arrangement, it makes tuning possible over a broad band of wavelengths.

* * *

QUESTION: What would be the best kind of tube to use in the set described on page 295 of the August issue of POPULAR RADIO? In that set would it not be just as good to put the variable condenser in series with the lead-in from the antenna?

GEORGE SAUNDERS

ANSWER: Any soft detector tube such as the UV-200, or the Cunningham 300, or an Electron Relay, will be serviceable for use with this circuit. The circuit will function better as shown in our diagram, with the antenna circuit tuned with the slider and the secondary circuit tuned by means of the variable condenser.

* * *

QUESTION: What are "damped" and "undamped" waves? What do we mean by "wavelengths from 200 to 700 meters"? In other words, to what does "wavelength" refer?

GLENN E. DILL

ANSWER: An "undamped" wave refers to an alternating current in which the amplitude of each succeeding alternation is constant. This is the type of energy developed by a vacuum tube transmitter, an arc transmitter, or a high frequency alternator.

A "damped" wave refers to an alternating current in which the amplitude of each succeeding alternation is of a decreasing value. This dampens out the oscillations in a circuit so that they finally die out. This series of oscillations is called a wave-train, and is generated by a spark transmitter. There is a wave-train generated for each spark jumping the gap in such a transmitter.

By "wavelength" is meant the distance traveled by a radio wave upon leaving an antenna before the next wave generated leaves the antenna. By referring to the water-wave analogy, the wavelength of any wave is the distance from crest to crest of the waves. Wavelength should not be confused with the distance the waves can travel. Refer to the article on page 47 of the June number of POPULAR RADIO.

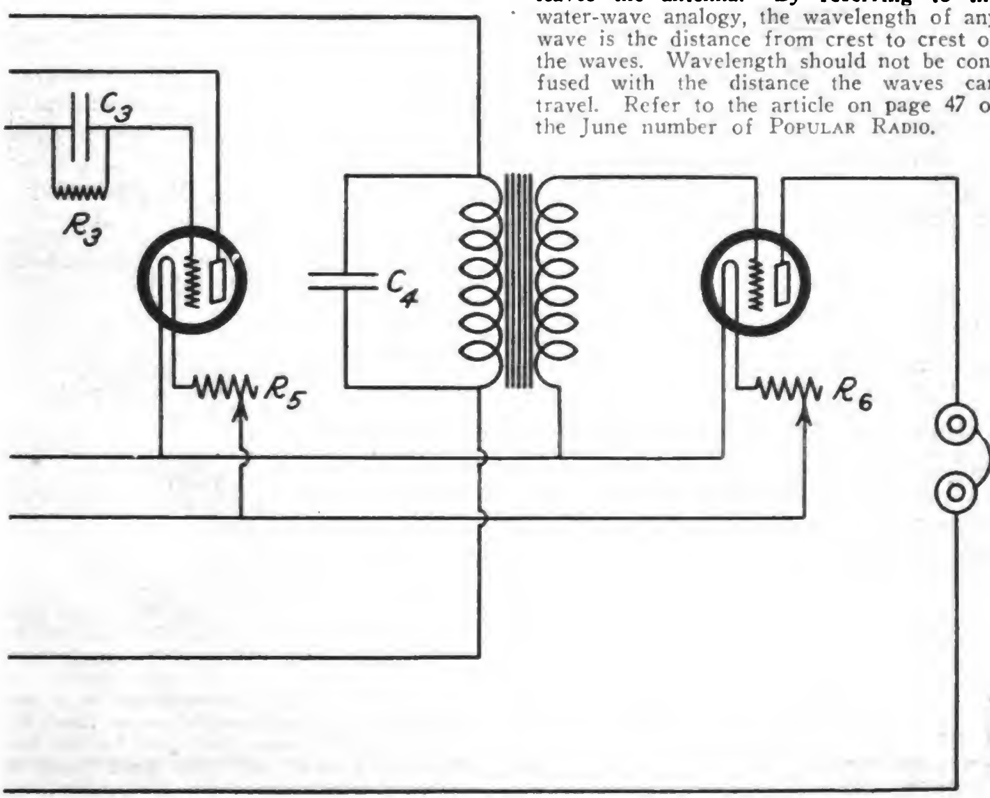
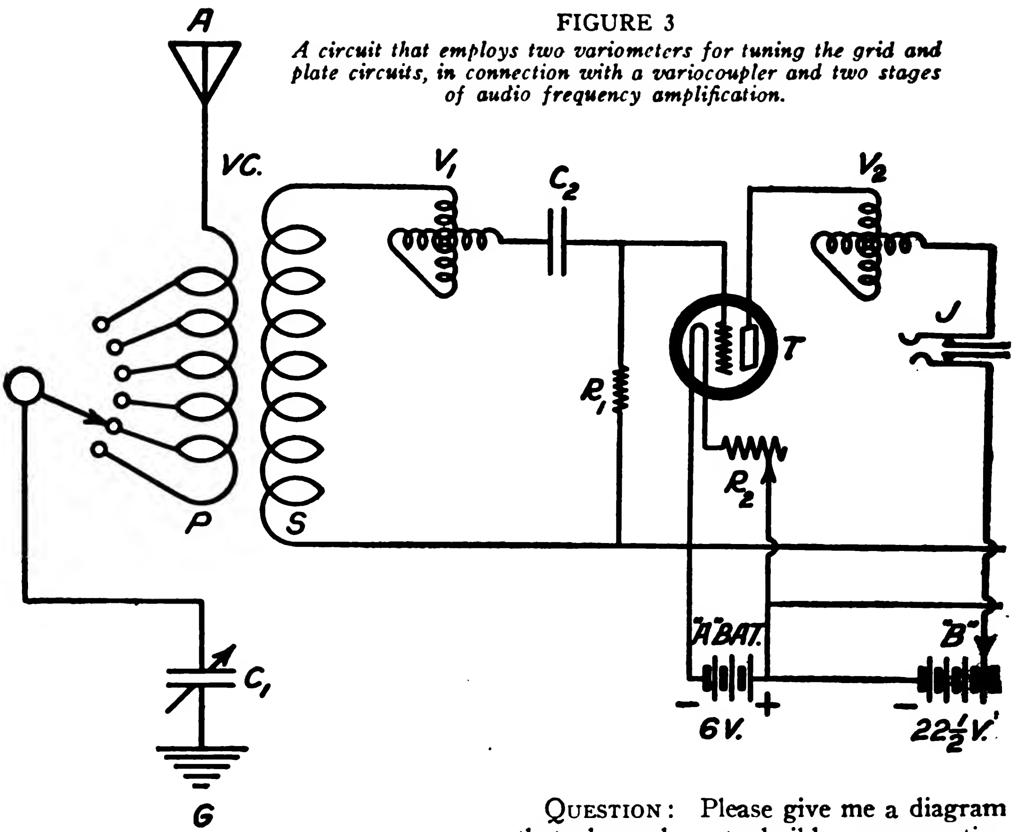


FIGURE 3

A circuit that employs two variometers for tuning the grid and plate circuits, in connection with a variocoupler and two stages of audio frequency amplification.



QUESTION: Please give me a diagram for a detector and two-stage amplifier set, using two Amrad variometers and an Amrad variocoupler for tuning.

R. A. McMILLIAN

ANSWER: The diagram has been drawn for you in Figure 3. This should make a very fine receiver for both amateur work and broadcast reception.

* * *

QUESTION: Please send me a diagram of a hook-up for my instruments. The tuner consists of 2 variometers, 1 variable condenser, and 1 variocoupler. Two stages of amplification should be added.

EVERETT BEERS

ANSWER: Refer to the diagram in Figure 3 for the circuit connections for your proposed set. You will notice that telephone jacks are inserted in the plate circuits to cut in or out of amplification.

The variocoupler and variable condenser tune the antenna, while the two variometers tune the grid and plate circuits.

QUESTION: Please give me a diagram that shows how to build a regenerative set, adding a 2-stage audio frequency amplifier.

C. W. WOODRUFF

ANSWER: The diagram shown in Figure 3 gives you the hook-up. The following parts will be required:

V1—Variometer
V2—Variometer
VC—Variocoupler
C1—Variable condenser, .001 mfd.
C2—Fixed grid condenser, .0005 mfd.
R1—1 megohm grid leak
T—6 ohm rheostat
T—Vacuum tube UV-201
T1—Vacuum tube UV-201
T2—Vacuum tube UV-201
J—Double circuit jack
J1—Double circuit jack
J2—Single circuit jack
AT—Amplifying transformer
A—6-volt storage battery, 60 ampere-hour
B—"B" battery dry cells, 22½ volts on the detector tube and 90 volts on the amplifier tubes

Three tube sockets, connecting wire and binding posts should enable you to finish the set. Use 3,000 ohm telephones for the best results. This set will give good results if properly constructed.

QUESTION: Please tell me if a variable condenser will tune out the terrible popping static that I hear over my crystal set. I also want to know if there is any addition I can make to my set that would increase the volume of music that I hear 25 miles away on 360 and 483 meters.

IRVING RUST

ANSWER: The variable condenser will not help you tune out the static. You would find some relief if you were to use a loop antenna, but this necessitates using multi-stage radio frequency and audio frequency amplification for loud signals. You will be able to increase the volume of your received signals by adding a vacuum tube to your set as a detector in place of the crystal detector, and at some future date adding another vacuum tube as an amplifier.

* * *

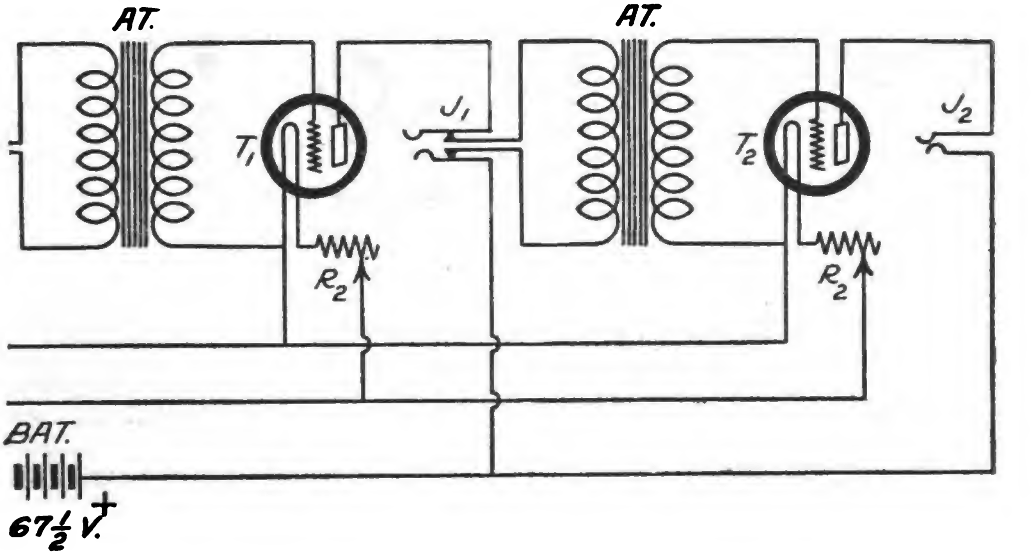
QUESTION: I would like to know which is the better plan—to amplify before I detect, or *vice versa*.

ROBT. FARD

ANSWER: In radio frequency amplification, the incoming impulses are amplified before they are detected, and when audio frequency amplification is used the impulses are detected and then the low frequency component of the current is amplified.

Radio frequency amplification is more suitable for amplifying weak signals so that the detector is furnished with enough current to function, and audio frequency amplification is used when the signals have already been detected and when signals of sufficient strength to operate a loudspeaker are required.

The two systems of amplification cannot be compared because they have different functions. The best results are obtained when the two systems are employed in combination and amplification is obtained both before and after detection.



* * *

QUESTION: Please explain the method of amplifying the signals as received with a single crystal detector, by means of additional crystals and amplifying transformers, and state the degree of amplification obtained.

E. O. KNOCH

ANSWER: The technical editor has seen the diagram of such a circuit, but he is "from Missouri" in regard to its practical application. It stands to reason that in the crystal detector receiver, the strength of the received signals is a function of the current passed through the crystal. If we step up the voltage by means of amplifying transformers, the current in the next crystal is decreased and the signal is weakened. If, on the other hand, we should step down the voltage in order to increase the current through the second crystal, the voltage would be of too low an order to overcome the high resistance of the crystal and again the signals would be weakened. If this method were successful it would very probably be in common use. Our advice is to stick to the vacuum tube as an amplifier.

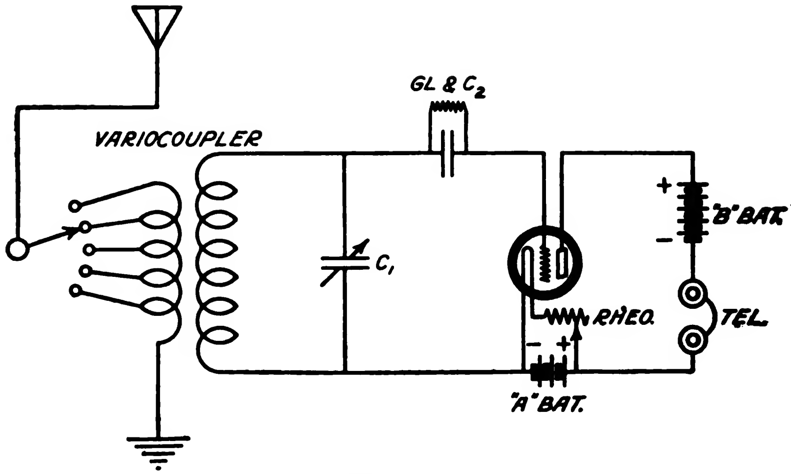


FIGURE 4

A circuit that makes use of a variocoupler, a variable condenser, and a vacuum tube.

QUESTION: Please show me an efficient diagram using a variocoupler, a variable condenser and a vacuum tube detector.

HENRY C. JONES

ANSWER: The circuit diagram you require is shown in Figure 4. The tuning is accomplished by means of the primary switch and the variable condenser.

* * *

QUESTION: I have already made a receiving set a little different than the one described in your May issue, but I have had very little luck with it so far. I enclose the hook-up that shows the instruments I use, and the antenna. Can you find my error?

CECIL LAMGKUR.

ANSWER: You will improve your set if you use the circuit for hooking up your apparatus as illustrated in Figure 5. The antenna you have is much too small. Use one wire stretched as high as possible and at least 100 feet in length (but not longer than 150 feet) for listening to the broadcasting programs.

* * *

QUESTION: I have a loose coupler, a fixed condenser and a crystal detector. Can I make a set out of them that will receive code messages and music? If so please give me a wiring diagram for the set.

D. STAFFORD

ANSWER: A circuit employing the instruments that you have on hand is given in Figure 5. This will allow you to receive local code and broadcasting quite clearly.

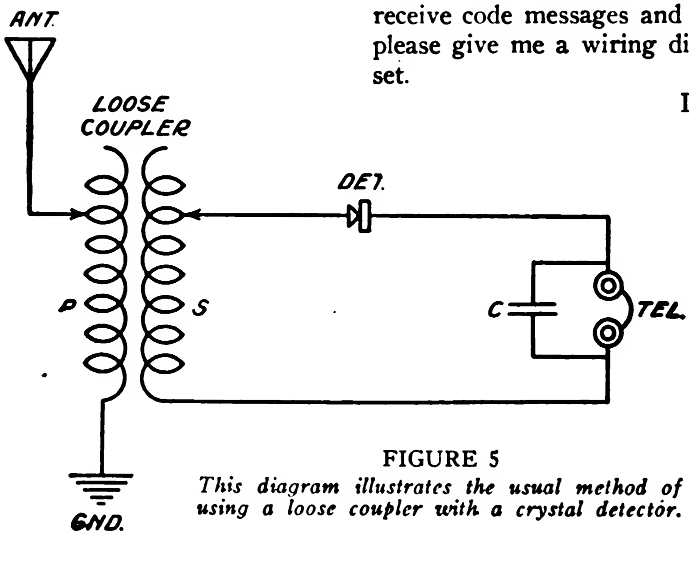


FIGURE 5

This diagram illustrates the usual method of using a loose coupler with a crystal detector.

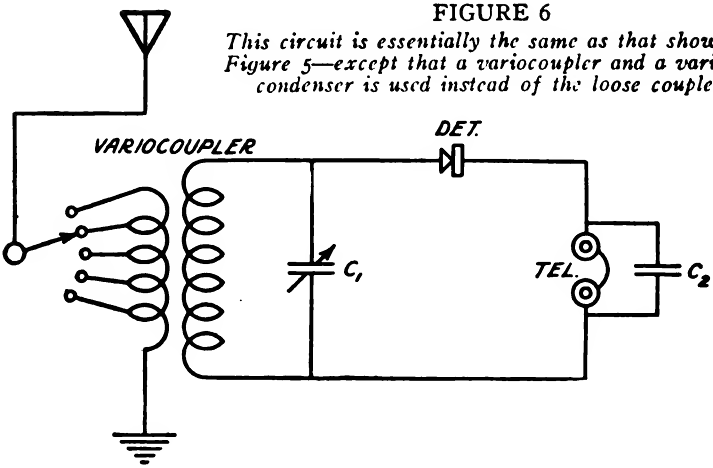


FIGURE 6
This circuit is essentially the same as that shown in Figure 5—except that a variocoupler and a variable condenser is used instead of the loose coupler.

QUESTION: Please give me a diagram showing how to wire up a variocoupler tuning coil with crystal detector and where to put the variable condenser. My aerial is 100 feet long and 30 feet from the ground, made of No. 14 bare copper wire without an enamel coating on it. Will it be all right without the coating?

P. A. LATTA

ANSWER: The diagram that you require is drawn for you in Figure 6. The bare copper wire will be suitable.

* * *

QUESTION: Which is the best, a loose coupler, a variocoupler, or a variometer? How many miles would I be able to receive with one of the above, and a phone condenser, a 43 plate variable condenser, a crystal detector, and a pair of 2,200 ohm phones?

JOHN COLLINS

ANSWER: The variocoupler will give you the most satisfactory method of tuning. See the diagram shown in Figure 6 in answer to the question of P. A. Latta. It is not possible to answer questions regarding the distances over which a set should receive.

* * *

QUESTION: Is there any way in which the set described in the July issue of POPULAR RADIO (on page 194) can be made to receive over greater distances? I hear the local stations clearly but want to increase the range.

T. J. LAUGHLIN

ANSWER: On page 168 of this magazine you will find another article by Watson Davis; it shows how to add a vacuum tube detector to the set you describe, thus increasing its range considerably.

* * *

QUESTION: Please give me an efficient hook-up for the following instruments:

1 variable condenser
1 fixed condenser
1 variocoupler with a tapped primary
1 crystal detector
1 pair of head-telephones

HENRY C. JONES

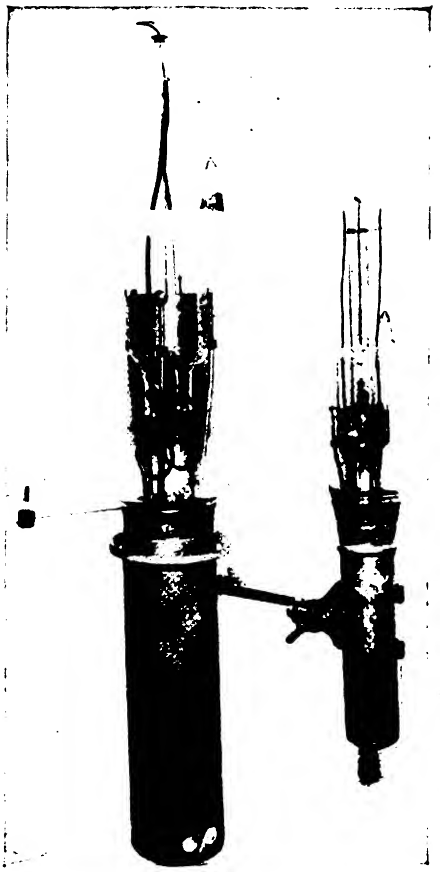
ANSWER: The hook-up is shown in Figure 6.

* * *

QUESTION: Can a 6-volt and a 22½-volt D. C. generator be used, instead of the "A" and "B" batteries respectively, in a vacuum-tube receiving set?

VICTOR NEHER

ANSWER: These may be used providing the direct current, generated by the machine, is non-fluctuating. If the current is of a pulsating nature, such as is generated by most machines of small size, there will be a humming sound accompanying the reception that will cause interference. This may be eliminated by the use of a filter circuit connected in the plate circuit of the tube. Such a circuit was described and a diagram given on page 144 of the June issue of POPULAR RADIO. The filter circuit shown on this page is one recommended for use with a radiophone transmitter, but it can be used advantageously for receiving sets.



Compare the tiny tube (which is still used for receiving) with the latest 100 kilowatt oscillator which has just been produced—the most powerful vacuum tube in the world, 100,-000 times as powerful as its companion. The tube at the right is the 10 kilowatt oscillator from which it was developed.

The "Peanut" Tube's Giant Brother

The latest and the most powerful of vacuum tubes that weighs but ten pounds—but that may conceivably do the labor of $500,000 worth of machinery

By W. WILSON

INTRODUCTORY NOTE

Here is a description of an amazing triode, scarcely two feet in height and weighing only ten pounds, that is nevertheless capable of delivering 100 K. W. of high frequency energy —truly an "Aladdin's lamp" of radio raised to the *n*th power. It is not inconceivable that this tube may become one of the most remarkable devices of modern electrical science.

Vacuum tubes capable of handling small amounts of power have been extensively used during the past few years as telephone repeaters and as oscillators, modulators, detectors and amplifiers in radio transmission and other fields. Practically all such tubes have depended upon thermal radiation from the plates to dissipate the electrical energy which the device necessarily absorbs during its operation. With present methods of construction, and using glass for the containing bulb, a fairly definite upper limit can be set for the power which a radiation cooled tube can handle; as the author points out, this limit gives a tube capable of delivering about 1 to 2 K. W. when used as an oscillator.

Contrasted with this is the large water-cooled vacuum tube described herewith. Another tube of similar construction, but somewhat smaller in size, is capable of delivering about 10 K. W. It is expected that these water-cooled tubes will find important application in radio telephony and telegraphy.

Although the principle of operation of the water-cooled tube described in this article is identical (from an electrical point of view) with that of the small tubes with which we are now so familiar, their practicability has been made possible only by a new and striking development in the art of sealing metal to glass. In the case of the 100 K. W. tube the seal between the cylindrical copper anode and glass portion is 3.5 inches in diameter.

The remarkable character of these copper-in-glass seals is evidenced by the fact that they do not depend upon a substantial equality between the coefficient of expansion of the metal and glass. The development of the copper-in-glass seals was brought about by Mr. W. G. Houskeeper of the Bell System Research Laboratory at the Western Electric Company. Mr. Houskeeper has also invented means for sealing heavy copper wire and strip through glass in such a way that the best vacua can be maintained under wide changes of temperature. —EDITOR.

THE widespread adoption of the vacuum tube as the generator of high frequency currents in low power installations has been brought about by just two factors.

One is the development of radio telephony.

The other is the use of continuous wave transmission in radio telegraphy.

The ordinary form of vacuum tube is, however, ill suited for the handling of large amounts of power, and at the large radio stations, where the plant is rated in hundreds of kilowatts, either the arc or the high frequency alternator is used.

The undoubted advantages to be derived from the use of vacuum tubes (especially in the field of radio telephony where the output power must be modulated to conform to the intricate vibration pattern of the voice), has led to a demand for tubes capable of handling amounts of power comparable with those in use at the largest stations.

That the development of such tubes was of great importance was recognized by the engineers of the Bell Telephone System in the early days of the vacuum tube art. The experiments at Arlington, Virginia, in which speech was first transmitted across the Atlantic to Paris and across the Pacific to Honolulu, required the use of nearly 300 of the most powerful tubes then available, each capable of handling about 25 watts, and the difficulties encountered in operating so many tubes in parallel gave added impetus to the development of high power units.

The usual type of vacuum tube consists of an evacuated glass vessel in which are enclosed three elements: the filament, the plate, and the grid. When the tube is in operation an electron current flows between the filament, which is heated by an auxiliary source of power, and the plate, the magnitude of this current being controlled by the grid.

The passage of the current through a thermionic tube is accompanied by the dissipation in the plate of an amount of power which is comparable to the power delivered to the output circuit and which manifests itself in the form of heat. This causes the temperature of the plate in the usual type of tube to rise until the rate of loss of heat by radiation is equal to the power dissipated. Some of the heat liberated by the plate is absorbed by the walls of the containing vessel, which consequently rise in temperature. These factors, together with a consideration of the size of plate that can be conveniently suspended inside a glass bulb, and the size of glass bulb that can be conveniently worked, set a limit of about 1 to 2 K. W. for the power that can be dissipated in the plate of a commercial vacuum tube of this type.

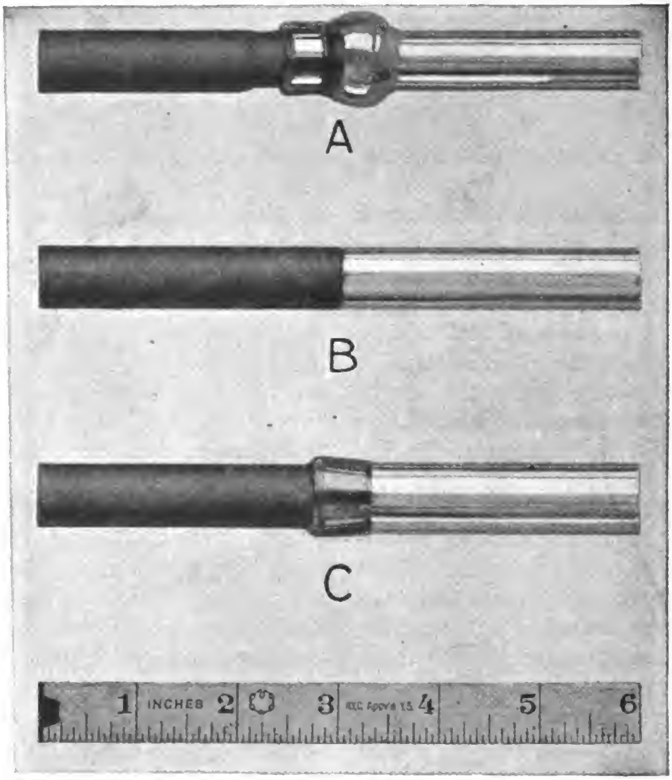
It is apparent then that in the development of vacuum tubes capable of handling large amounts of power, means other than radiation must be used for removing the heat dissipated at the plate, and development of tubes has proceeded along these lines.

A step in the direction of overcoming these limitations was made by Messrs. Schwerin and Weinhart, who were working with Dr. O. E. Buckley on the problem, and who suggested that the anode might be made in the form of a tube or thimble of platinum sealed into a glass vessel and kept cool by passing water through it.

As soon as the pressure of work more directly connected with the necessities of the war would permit, Mr. W. G. Houskeeper and Dr. M. J. Kelly undertook the improvement of the water-cooled tube.

Mr. Houskeeper adapted into the construction of the tube a remarkable type of vacuum seal which he had previously developed. These seals are made between glass and metal and can be made in any desired size. They are capable of withstanding repeated heating and cooling over wide ranges of temperature, from that of liquid air to 350° C., without cracking and without impairment of their vacuum holding properties.

It is no exaggeration to say that the invention of these seals has made possible



THESE THREE JOINTS MAKE THE GIANT TUBE POSSIBLE

Three types of the "tube seal," A, B and C, that are used for producing the air-tight joints between the glass and the metal of the monster tubes.

the construction of vacuum tubes that are capable of handling, in single units, powers of any magnitude which may be called for in radio telegraph and telephone transmission.

The underlying principle connected with the making of this seal consists in obtaining an intimate connection between the glass and metal, either by chemical combination or by mere welding and in so proportioning the glass and metal portions of the seal that the stresses produced when the seal is heated or cooled will not be great enough to rupture either the glass or the junction between the glass and metal.

The three principal types of seals developed by Mr. Houskeeper are known as the ribbon seal, the disc seal and the tube seal.

The type of seal which is the most important in connection with the present problem is the tube seal shown in the illustration on this page. This furnishes the means of joining metal and glass tubes end to end, and is used in the water-cooled tube to attach the anode to the glass cylinder which serves to insulate the other tube elements. As in the case of the disc seal, it can be made either with the edge of the metal not in contact with the glass, as shown at A, or with the metal sharpened to a fine edge which is in contact with the glass. The glass may be situated either inside or outside of the metal (see B and C.)

The first thermionic tubes in which these seals were embodied were made of copper and were designed to operate at 10,000 volts and to give 5 K. W. output.

Although successful from the standpoint of operation, this tube had several

undesirable features that it was thought well to eliminate. In the first place the welding of the end into the tube was not particularly desirable, and in general any troubles that occurred due to leaks in the metal could be traced to this point. It was, therefore, decided to go to a type of tube in which the anode would be drawn in one piece and in which as many welds as possible would be eliminated in the assembly of the internal elements. At the same time it was considered desirable to go to a somewhat larger type of structure in which high tension insulation could be more easily provided, and a larger tube was therefore designed capable of delivering 10 K. W. to an antenna at a plate voltage of 10,000 volts.

The final form adopted for this tube is shown on page 219.

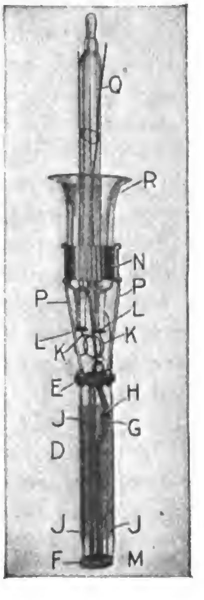
The success which had attended the development of a tube of this high power capacity indicated the possibility of constructing still larger tubes, and it was decided to proceed with the development of a tube capable of delivering at least 100 K. W. into an antenna. The development proceeded with a few minor alterations along the lines of the smaller tube, nominally rated at 10 K. W., and the 100 K. W. tube as now developed is shown in the frontispiece of this magazine. The anode, which is made of a piece of seamless copper tubing closed by a copper disc welded into the end, is 14 inches long and 3.5 inches in diameter. The filament is of tungsten and is .060 inch in diameter and 63.5 inches long. The current required to heat it is 91 amperes, and the power consumed in it 6 K. W. The filament leads are of copper rod one-eighth of an inch in diameter and are sealed through 1-inch copper disc seals. The grid is of molybdenum and is wound around three molybdenum supports.

The handling of the parts of this tube during manufacture presents a task of no mean magnitude, and numerous fixtures have been devised to assist in the glass working. It has been found necessary, for instance, to suspend the anode in gimbals during the making of the tube seal, owing to its great weight, and special devices have been made to hold the filament grid assembly in place while it is being sealed in, otherwise the strains produced by its weight cause cracking.

The significance of this development in the radio art cannot be overestimated. It makes available tubes in units so large that only a very few would be necessary to operate even the largest radio stations now extant, with all the attendant flexibility of operation which accompanies the use of the vacuum tube.

From the standpoint of radio telephony the development of these high-power tubes gives us the possibility of using very much greater amounts of power than have ever been readily available before. The filaments in these tubes have been made so large that the electron emission from them will easily take care of the high peak currents accompanying the transmission of modulated power.

The 100 K. W. tube by no means represents the largest tube made possible by the present development. There is no doubt that if the demand should occur for tubes capable of handling much larger amounts of power they could be constructed along these same lines.



HOW IT IS BUILT

The grid assembly is shown at D, and is supported by the rods M and the lavite blocks E and F. The filament is of tungsten and is connected to the two molybdenum rods G and H, which are coiled into single turn spirals at KK and led through the glass by the disc seals LL. The hooks J hold the lower end of the filament in position. The whole structure is mounted on the flare R by means of the nickel collar N and the supports P. The grid lead is brought out through the glass tube Q.

HINTS FOR AMATEURS

It is often a great help in tuning to have the antenna circuit of a receiving set tuned by a variable condenser, especially when the condenser can be placed in series with the circuit or in parallel. In order to make this system of the utmost convenience it is necessary to use some sort of switching arrangement that will allow the operator to make a quick change, so that time is not wasted in changing connections to the condenser.

A suitable method for doing this has always been a little too much for the novice in radio, probably because he thought it too complicated.

For the amateur who has his apparatus mounted on a board, a double pole, double throw knife switch will be suitable. It should be connected as shown in Figure 1, with the primary coil across the two contacts at one end of the switch, the condenser connected across the switch blades, and the antenna and ground leads connected on opposite sides of the switch, as shown in the diagram. The change-over lead should run from the bottom right-hand contact to the top left-hand contact. When the switch is thrown to the right the condenser is connected in parallel to the antenna circuit (tuning to the higher wavelengths); thrown to the left it is connected in series, when the lower wavelengths will be more easily tuned in.

There are two styles of switches that may be mounted on the panel and make a good appearance as well as work satisfactorily. One of them is the rotary change-over switch with two double ended switch arms and eight contact points (as shown in Figure 2). The other style is a panel-mounted anti-capacity snap switch with a small button protruding through the panel. This switch is shown in Figure 3, hooked up to an antenna circuit. A change-over switch is not necessary in the secondary circuit of a receiver.

* * *

A variometer is a very hard piece of apparatus for the amateur to construct himself, because of the fact that the stator winding must fit very closely to the rotor winding when the instrument is assembled. This necessitates special form-wound coils for the stator and a difficult method of transferring the windings from the forms to the blocks to which the winding is finally fitted.

There are many types of manufactured variometers which are suitable for amateur use and which are so reasonable in price that it is foolish for the amateur to think that he is saving either money or time, when he tries to make his own. After much planning, worrying and patience-testing labor he has an instrument that he calls a variometer, but it usually is an inferior instrument.

* * *

When experimenting with the new super-regenerative receiver the amateur is cautioned not to get discouraged until he has played with the set for a week or so and understands the principles of its operation. It is imperative that hard

tubes be used and they should be shifted around until the best tube is found for the regenerator and the best one for the oscillator. Upon such seemingly unimportant details is success based.

* * *

A LOOP antenna is not much of a success where a crystal detector is used alone in a receiving set. The results will be practically nil.

* * *

MANY novices confuse the wavelength of a transmitted signal with the distance the signal can be sent. Thus, some questions have been sent in to the "What Readers Ask" department, asking the wavelength from New York to Chicago, or the question "Will I be able to receive from a greater distance if I put in a loading coil?" This is a mistaken notion. The wavelength of a signal refers indirectly to its frequency or number of cycles a second, just as the pitch of a musical note refers to the frequency of the note or the number of impulses a second necessary to produce it, and not the distance it will travel.

* * *

Do not let your storage batteries run down dead, as this misuse will soon cause deterioration and the battery will be no good. When your battery shows signs of dropping, take it to the garage and get it recharged. Better yet, obtain a charging device and keep it always charged yourself by turning on the charger after you have used the set. The charging device will quickly pay for itself, as the battery lasts longer and you will save the money paid to the garage man for charging. A charger is a good investment at any time.

* * *

A HANDY kink for the radio experimenter to use is ready-made "leads" or insulated wires with small spring clips at each end. These may be made in varying lengths, so that when (during an experiment with a new circuit) he wishes to try some other connections, he need merely unclip the wires and reclip them in the new positions without the bother of cutting new leads, scraping the wires clean and fastening them in the binding posts. The new way is a time saver and much more convenient. Make

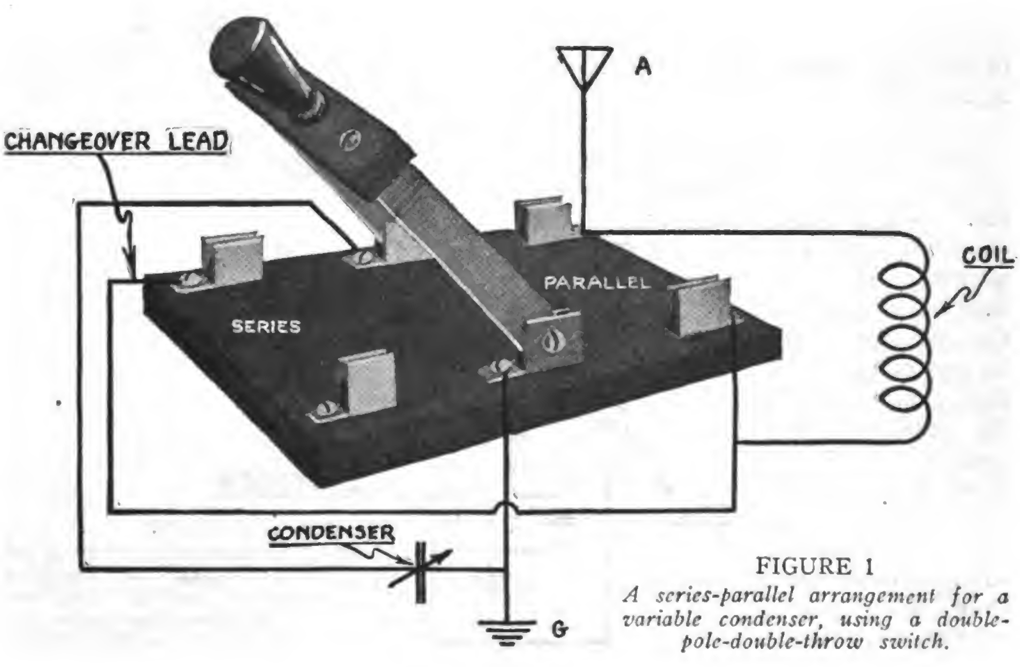


FIGURE 1
A series-parallel arrangement for a variable condenser, using a double-pole-double-throw switch.

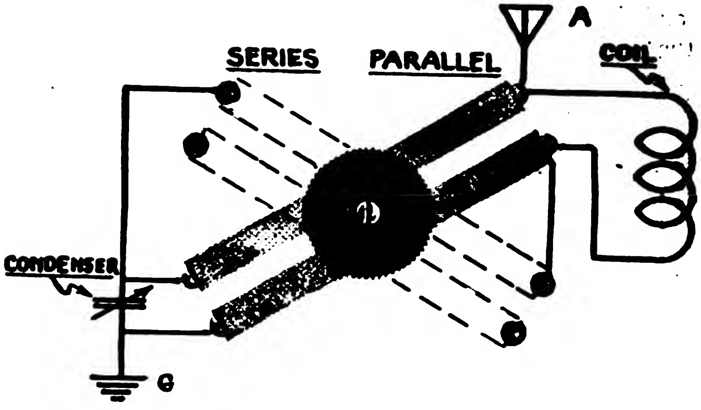


FIGURE 2

The same circuit as shown in Figure 1, except that a rotary panel switch is used.

up some testing leads and take the drudgery out of your experimentation.

* * *

An "A" battery is usually a storage battery of 6 volts and is used to heat the filaments of the vacuum tubes in the receiving set. A "B" battery is composed of a number of small flashlight dry batteries connected in series and are usually made up in blocks having 22½ volts a block. The "B" battery is used to make the plate of a vacuum tube sufficiently positive with respect to the filament to facilitate the passage of electrons across from the filament to the plate.

* * *

Sometimes the amateur has trouble with his receiving set, in that the signals come in loud and clear for a few minutes, only to fade out again. All the connections may be correctly and tightly made, still the same trouble continues. Sometimes this trouble may be located in the socket of the tube. The tube has four little prongs sticking out from the bottom of the base; on the end of each of these is a little drop of solder. This is supposed to make contact with the strips in the socket, but often the little dabs of solder get blackened and dirty and a poor contact is obtained.

This trouble may be easily remedied by polishing the bottom of each of the four little prongs with a piece of smooth sandpaper.

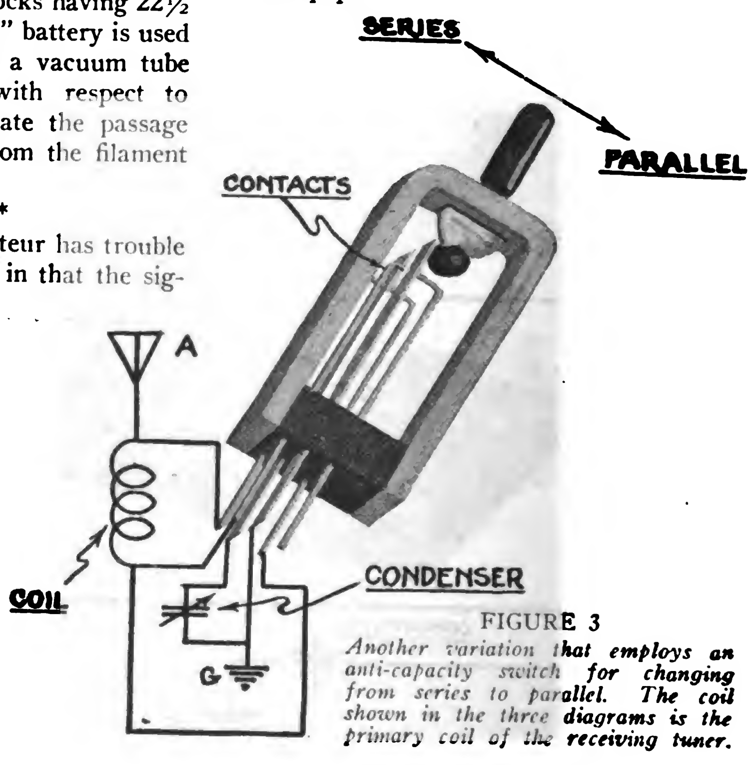


FIGURE 3

Another variation that employs an anti-capacity switch for changing from series to parallel. The coil shown in the three diagrams is the primary coil of the receiving tuner.

HELP *your neighbor. If you have discovered any little Kink that helps to eliminate trouble in your radio apparatus, or if while experimenting with the connections of your set you should run across some interesting phenomenon, or if you should discover some new hook-up that gives better results—send it to the "Listening In" page.*

A New Test for Amateurs

FOR the first time in the history of amateur radio American and Canadian amateurs will have an opportunity to demonstrate their skill in receiving amateur signals from across the Atlantic.

The third series of transatlantic amateur tests will be conducted by the American Radio Relay League, in co-operation with the radio amateurs of England, France and Holland, from December 12 to December 31, 1922, inclusive. During the first ten days of the tests American and Canadian amateurs will transmit signals for reception by the radio amateurs of the European countries. Those of the American and Canadian transmitters who make the best records (as determined by reception reports from the European amateurs) will be used to transmit the results of reception by American and Canadian radio amateurs when the English and French amateurs send.

A series of preliminary tests, for the purpose of determining which American and Canadian transmitters shall be given a place in the final tests with an individual schedule and code letters, will be conducted from October 25 to November 3, inclusive. To qualify for the final tests a transmitter must cover at least 1,200 air-line miles during the preliminary tests.

The preliminary tests will cover a period of two and one-half hours (9:30 P.M. to midnight, Central Standard Time) each night; this period will be subdivided into ten periods of fifteen minutes each. Transmission will take place by inspection districts. One district will transmit at a time, and all others will remain silent during the attempt to copy as many of the transmitting stations as possible. After the tests each night the receiving stations will send a confirming record to all transmitters at a distance of 1,200 air-line miles or over. When filing application for entry in the final tests, a transmitter must show documentary evidence that his signals have reached out 1,200 air-line miles during the months of September or October.

Pacific & Atlantic

A FINGER-RING RECEIVER

This is claimed to be the smallest set made. Do our readers know of one smaller?

A PAY-AS-YOU-ENTER STATION

To meet the demand for a broadcasting toll station—a station that can be hired for occasions—the American Telephone and Telegraph Co. has established WBAY atop this conspicuous building in New York. The antenna towers are 488 feet above the sidewalk, and are built to withstand a wind load of 5,000 pounds. The result of this unique experiment is being watched with more than casual interest.

Radio Fans to Pay Tribute to John Bull

HOW John Bull is treating the radio amateur in England—where radio has not yet taken hold in anything like the way it has on this side of the ocean—is revealed in the interesting comment of Mr. A. P. M. Fleming, a prominent English engineer, who recently visited some of our large broadcasting stations:

At present we have no such thing as broadcasting in Britain in the sense in which the term is used in America. Government restrictions have prevented it on account of the possible interference with the requirements of the navy, mercantile marine, war services, and aeroplane traffic. But the largest manufacturers of radio apparatus have co-operated with the British Government officials in working out plans for the control of broadcasting.

We have learned many valuable lessons from the broadcasting experience of the United States. One of them is to avoid the establishment of innumerable radio stations, with no plan of cooperation between them. Eight 1½ K.W. stations are contemplated and some of these will probably be built shortly. These stations will be located in the principal cities throughout the British Isles and will be operated so as to eliminate the chaos usually found where no rules are in force.

The broadcasting stations will be operated on strictly regulated wavelengths and other set rules, which will be published for the guidance of radio receiver owners. Every radio set owner will be required to pay an annual tax, also, and there will doubtless be special restrictions applying in times of national emergency.

* * *

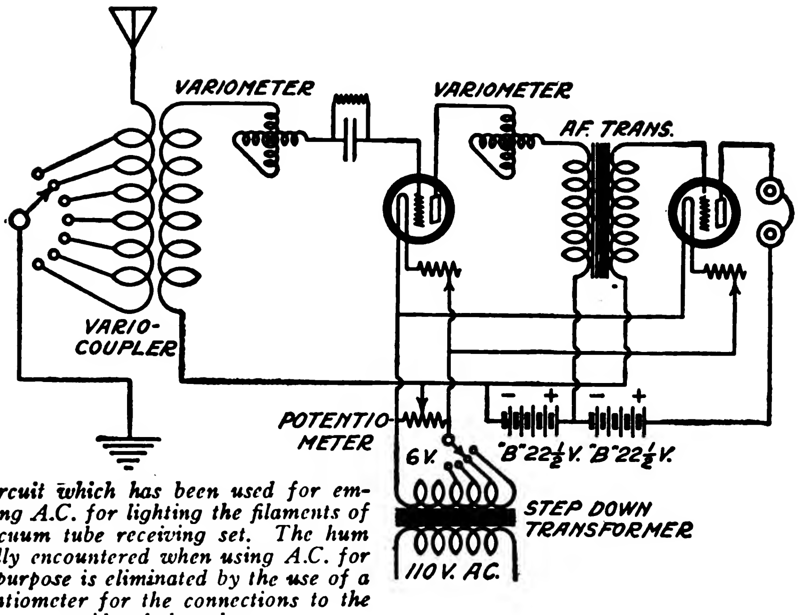
A Toy Step-Down Transformer in a Receiving Set

IF you receive an electrically operated toy railroad train from Santa Claus, you may adapt a part of it for a novel use on your radio set, as this experimenter did:

I am using a toy transformer on my apparatus with great success. I get very little hum when the set is properly tuned, due to the fact that I use a potentiometer across the transformer, with the "B" battery negative pole connected to the switch arm, as shown in the accompanying diagram. The transformer is especially successful when using the loudspeaker, as the hum carries only a few feet while the signals may be heard all over the room. I am using a regenerative circuit with one stage of audio frequency amplification.*

A. THOMAS WELLS

*See circuit diagram on page 223.



A circuit which has been used for employing A.C. for lighting the filaments of a vacuum tube receiving set. The hum usually encountered when using A.C. for this purpose is eliminated by the use of a potentiometer for the connections to the grids of the tubes.

The New "Class B" Stations

A DISTINCT step forward in the broadcasting problem has just been taken by the Washington authorities through the Secretary of Commerce, Herbert Hoover. A new "Class B" station has been created that shall have special wave-length assignments and that shall be specifically charged with the maintenance of high-grade programs—not unlike the special "red seal" records of the gramophone. The next step in the development of the plan will be to maintain these programs at the highest possible level; on this point, indeed, POPULAR RADIO has been quietly working for several weeks; the results will be published in a subsequent issue. Secretary Hoover's announcement reads as follows:

A new class of radio telephone broadcasting station license is hereby established, to be known as Class "B." A license will not be issued for a station in this class which does not comply in every respect with the specifications hereunder.

Specifications covering the requirements governing the construction, licensing, operating and service of Class "B" radio telephone broadcasting stations:

Wavelength—The wavelength of 400 meters only will be assigned for the use of stations of this class, which must be reasonably free from harmonics.

Power—The power supply must be dependable and nonfluctuating. The minimum required will be 500 watts in the antenna and the maximum shall not exceed 1,000 watts in the antenna.

Modulation—The system must be so arranged as to cause the generated radio frequency current to vary accurately according to the sound impressed upon the microphone system.

Spare Parts—Sufficient tubes and other material must be readily available to insure continuity and reliability of the announced schedule of service.

Antenna—The antenna must be so constructed as to prevent swinging.

Signaling System—Some dependable system must be provided for communication between the operating room and the studio.

Studio—The radio equipment in the studio must be limited to that essential for use in the room. The room shall be so arranged as to avoid sound reverberation and to exclude external and unnecessary noises.

Programs—The programs must be carefully supervised and maintained to insure satisfactory service to the public.

Music—Mechanically operated musical instruments may be used only in an emergency and during intermission periods in regular program.

Division of Time—Where two or more stations of Class "B" are licensed in the same city or locality a division of time will be required if necessary.

Licenses issued for the use of the 400 meters wavelength shall specifically provide that any failure to maintain the standards prescribed for such stations may result in the cancellation of the license and requiring the station to use the 360 meters wavelength.

A Fly-Screen for an Aerial

HERE are some practical ideas with which the radio novice may like to experiment; all of them presage the ultimate passing of the expensive and troublesome outdoor aerial that still leads all other types in efficiency:

A standard aerial, while productive of the best results in radio reception, is not always necessary; there are many substitutes. Those radio fans who have no place to install the regulation type may receive by any one of the following means if long distance work is not contemplated.

A metal porch screen will often play the part of an aerial. If the screen is in sections, try each section separately; then try connecting two or three or all of them together. I find that the section parallel with the house will receive some stations well, but it will not get others at all;* sometimes the screen at right angles to the house will get signals that the other screens will not; hence it would be well to do a little experimenting.

The wires used in houses equipped with electric bells may also serve as aerials. If you try this it is well to go over the wires and see that they are not grounded; if they are, you are doomed to disappointment. Whenever the wire touches a radiator, gas pipe or water pipe, either take it away or insert a piece of rubber or other insulating material between the wire and the metal. Fairly good signals may ordinarily be obtained this way.

Another makeshift that has sometimes proved useful is the telephone. Merely connect a wire from the aerial terminal of the radio to a metal part of the telephone (not to the telephone wires or binding posts) and then tune in. Excellent results are sometimes produced by this method, if the telephone wires are brought to the house from an outside pole—but underground wires do not always work as well.

LEROY WHITMAN

This is due to the directional effects of the vertical screens.

Radio Corporation of America

A LISTENING-IN POST AMONG THE CLOUDS

How modern science is slowly but surely reducing time and space was aptly illustrated by the inter-continental flight of the seaplane "Sampaio Correia," which left New York August 16th for its eventful effort to reach Brazil. It was equipped with a radio receiving set with a range of 500 miles, which enabled Lieut. Walter Hinton, the pilot, to keep in communication with shore stations and vessels—not only for the purpose of receiving weather reports, but even for purposes of entertainment. It was entirely possible for the adventurers in the sky to hear the New York Philharmonic concert the evening they set forth!

International

Official photograph, U. S. Navy

THE TELETYPE ON AN AIRPLANE

In order to insure the proper transmission of radio messages to naval planes in flight, successful experiments have been made in typing the signals, thus overcoming the difficulties of receiving the messages by ear.

A Ghostly Hand on the Keyboard

ONE of the chief difficulties in communicating by radio between airplanes in flight, or between land stations and airplanes in flight, has been to overcome the great noise of the engines sufficiently to enable the operators to hear the signals. Recent experiments at the Anacostia Naval Air Station, near Washington, D. C., would indicate that this problem is being solved at last by the "teletype"—a typewriting machine that is operated from a distance by radio. The instrument employed is the type familiar in commercial work; it consists of sending and receiving parts. The sending instrument (which may be mounted in a standard type of Navy plane) resembles in general the commercial typewriter that is equipped with keyboard letters and other conventional symbols operated by hand. Each key is connected with the radio installation of the transmitting set; when a letter is struck on the keyboard a radio impulse is sent out from the antenna of the plane and is recorded in the similar key at the receiving instrument. The transmitter is shown at the top of this page, and the teletype—which types the radio message before the pilot's eyes—is shown in the smaller cut.

Married by Radio

EVER since the attempt to broadcast the marriage ceremony of Princess Mary, daughter of King George, in Westminster Abbey, when even the radio fans of the United States had hopes of listening-in on this more or less historic event, various (and more successful) efforts have been made to let the eavesdropping world attend weddings. For instance:

Perhaps the first such ceremony ever successfully broadcast was that which united Miss Helen B. Cook to John H. Collier in the Church of the Covenant at Washington, D. C., on September the sixth. Listeners-in were given plenty of time to tune in sharply, for the ceremony was announced long in advance, and the wedding march was played as an overture. From an advantageous position the words of the minister, the Rev. John C. Palmer, as well as the troths of the couple, were caught by the acousticon.

Sermons which have been broadcast from this church in the past have been received as far as Alabama; it is reasonable to believe, therefore, that the privacy of the ceremony was "invaded" by many receiving fans.

LEROY WHITMAN

* * *

One Concert Heard in 48 States

THE rapidly extending influence of radio is dramatically demonstrated in this news item from San Francisco:

In an effort to determine how great is the range of station KSD, a program of music by exceptional talent was given Sept. 12th between 11 P. M. and 1:27 A. M. A flood of telegrams which followed gave complete proof that the broadcasting test was heard in every one of the forty-eight states in the Union. So far as can be ascertained, no other broadcasting station in the United States has ever been heard, in a single night, over so vast a territory.

© Harris & Ewing

RADIO IS PUT IN JAIL AT LAST!

To be apprehended by means of radio and then to be entertained by it in jail is the ironical outlook for lawbreakers in Washington, D. C. The inmates there may stretch themselves out on their prison cots and listen to the stirring strains of the United States Navy Band, the daily police reports on stolen automobiles, and perhaps they may even speculate on the ease with which the radio waves penetrate the stone walls of their prison. A loop aerial is used to catch the waves for the receiving set. After using ear phones to tune in, the operator switches the programs on to a loud-speaker placed in the rotunda of the jail; by this means the inmates in the distant cells hear the entertainment plainly. Often, however, Captain W. L. Peak allows the three hundred and twenty men to leave their cells and come down to the auditorium.

WHAT *is the biggest thrill YOU ever got over the radio? Have you ever picked up a call for help? Or located a lost friend—or helped to run down a fugitive, or listened in on a conversation of peculiar personal interest to yourself? For every anecdote, humorous or grave, ranging from* 50 *to* 300 *words in length, the Editor will pay upon acceptance. Address contributions to the Editor,* ADVENTURE IN THE AIR DEPARTMENT, 9 *East* 40*th Street, New York City.*

A Real Prince Springs a Surprise Party

ONLY a few of the radio fans today will recall the following episode—and those few may well be called the "Old Timers" of radio:

Long before the advent of the present popular radio telephone, back in the days when the only radio amateurs were the chaps who mastered the International Morse code, and little dreamed of ever being able to hear anything over the radio waves except the dots and dashes that spelled out the messages letter by letter, a mysterious steam yacht glided slowly one night into New York harbor, up past the skyscrapers of Manhattan to an anchorage up in the Hudson River opposite Riverside Drive, where she dropped anchor and hoisted her riding light.

No shore-going party left her side in the little gasoline tender. Her distinguished owner had business aboard that night; he had a little surprise to spring upon America—a surprise which no one but a man of much wealth could afford to spring. It had taken time and money and plenty of genius and imagination to prepare this surprise party.

I was listening in myself that night. Soon I and my fellow amateurs were listening to something I had never before heard—music by radio telegraph!

First came the "Star-Spangled Banner"; then "Yankee Doodle," followed by the "Blue Danube Waltz" and other selections. The word spread like wild-fire. Station called station and passed the word, "Listen in for the music on 550 meters." Ships at sea heard it, stations up and down the coast and the amateur stations back inland were getting it. Whence came the music and how was it played?

It was not until twenty-four hours later, when the press announced the arrival of the Prince of Monaco on his yacht the *Hirondel* and told of his marvelous new "wireless invention," that anyone knew.

The visitor was none other than the Prince himself. He had voyaged all the way to America from his palace on the shores of the Mediterranean for the express purpose of springing his surprise on America.

How did he do it? It was a clever arrangement. Anyone who has ever listened in to the radio stations transmitting messages by the spark system will recall that each station has its characteristic note, the musical pitch of which is governed by the adjustment of the apparatus in use. The Prince had arranged his radio transmitter with a set of piano keys so that each individual key, when depressed, would transmit a spark signal at a certain adjustment for pitch; by properly adjusting the device for frequency and pitch he had produced a complete musical scale, and it was then only necessary for him to play the instrument just as one plays a piano. For variety, he would pause now and then on one particular note, and by depressing and releasing that key at intervals he transmitted a few words of jest in code, after which he would continue the air he had started to play.

When the Prince up-anchored and sailed away he did so with the satisfaction of having accomplished his mission.

E. JAY QUINBY.

My Apparatus Fails at a Critical Moment

HERE is a real case of "take it or leave it." It comes from a radio operator on a vessel whose captain literally had to decide whether to rescue the crew of a

burning freighter, or to let George do it:

Six days out from Bishop's Rock, bound for Norfolk, and fighting a nor'wester, I picked up an SOS from a British freighter. It was late in the afternoon and I had been working a few ships that day, principally exchanging position reports, so I knew that we were the closest one to him. As it generally happens, my circuit breaker kicked out when I tried to start the motor generator and another ship, four hundred miles away, answered ahead of me.

We were just one hundred miles off the Britisher, and I got the other operator who answered the call to stand by. The freighter was afire in three hatches and burning rapidly; the water from the fire hose was entering the radio shack and putting the apparatus out of commission occasionally, so communication was poor and, to add to the difficulties, I had a hard time keeping the rest of the ships in the vicinity quiet. Finally conditions improved and I learned that there was no immediate danger; the freighter wanted a ship to come alongside and stand by until the fire was put out, or take the crew off if such action became necessary.

Our captain informed the Britisher that we could take the crew off as soon as we arrived, but could not stand by, for we were running short of fuel, and could not afford to lose much time. The Britisher then told us to proceed on our course, and the ship that answered the distress call first went to his assistance and stood by for two days before the fire was under control.

JOSEPH H. O'CONNOR

I Become a Radio Expert in a Week

ONE of the engaging features of radio—the one feature, indeed, that is most responsible for its universal appeal—is the fact that for a few dollars anyone can enter the new world of the ether. Radio is not for the exclusive few. And just to prove how simple and inexpensive it is for even an inexperienced novice to make a set at home, the "Boss" of one of the important newspapers of this country told one of his staff, a young woman just out of college, to build one and tell what happened. This is her story—as told in a personal letter to the Editor:

The Boss came to me and asked:
"Know anything about radio?"
"No."
"Know anything about how to handle tools?"
"No."
"Well then go ahead and make a radio receiving set."

Just like that!

It developed that the big idea was that the Boss wanted to prove that a simple but first-class radio receiving set could be built by anybody regardless of his or her knowledge of radio or mechanics in general. Evidently he sized me up up as the dumbest individual in that line in the office, so I was elected to be the goat. I was to build a working set and then write a series of articles telling in absolute detail how to do the thing.

We will draw a veil over what followed, as the story-books say. Suffice it to say that the set was built. And what is more, it worked. Not only that but it worked well, very well—doggone well, I should say in the language of my gang. Nobody was more surprised than I, when following a week's work, after I had managed to do everything at least one wrong way before getting it right, after I had covered myself with mahogany varnish and copper stain, after I had pounded my fingers and wound myself up in coils of wire, and after I had gone dizzy figuring out positions, I set the thing up, tuned in—and a perfectly good concert came pouring in over the phones!

Then I wrote twelve columns of "How," and told my prospective readers just how to bore a hole, put in a screw, and especially how *not* to do the things I did. The staff photographer came out, took some pictures that looked as if I was doing something with the set, and then we started the series of articles in the paper.

Then came along the radio show. And since my paper had made so much of its radio column (being the first paper to have one, and all that), we decided to have a booth. Among other attractions were to be Nancy and the set, both on exhibition. Nancy was to be there for the purpose of answering questions and proving that she and the set were both practical actualities. So we got out several thousand pamphlets that contained reprints of the first few chapters in the series and advising: "Read the rest in the—."

The crowds apparently liked the booth and apparently they liked Nancy. There was just one single set on the counter—not a lot of technical apparatus. As I found that most people knew even less about radio than I, the demonstrations registered strong.

It was good fun the first forty-eight hours. After that I could say; "It has a radius of 30 miles;" "Yes, it could be made for $15," in my sleep.

But the set and I went over with a bang, so after all, it didn't make much difference that I hadn't the courage to look an aerial in the face for a month after.

NANCY

¶ *So many inquiries have been received concerning the instruction in radio work that is being offered by the State Militia—instruction for which the student is paid—that* POPULAR RADIO *will shortly publish a sequel to "What the National Guardsman Is Doing with Radio" in the form of an article that will describe what the naval militiaman is doing with it—and he is doing a lot.*

WORKRITE CONCERTOLAS

WORKRITE CONCERTOLA SR.

"THEY SPEAK FOR THEMSELVES"

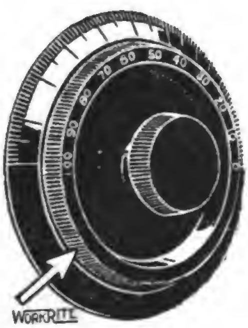
And they speak in a clear, loud tone because these Loud Speakers have been perfected and tested until they are worthy to be listed with "WorkRite" Products.

Except for the phone unit, THERE IS NOT THE SLIGHTEST METAL IN EITHER THE WORKRITE CONCERTOLA SENIOR OR JUNIOR. The sound chambers of the Concertolas are made from our specially developed material, which reproduces voice or music without the slightest distortion. IMPORTANT! Our engineers have perfected a special 5,000-ohm concert phone for use in these Concertolas. They are not sold separately. Test the WorkRite Concertolas side by side with ANY other loud speaker on the market—then you can see the superiority of "WorkRite." Cord and phone unit built in each instrument.

WorkRite Concertola Jr. $12.00 **WorkRite Concertola Sr. $24.00**

WORKRITE CONCERT HEADPHONE

Designed by one of the oldest telephone engineers in the country. Tested and improved until they are up to the "WorkRite" standard of excellence. The sanitary headband is made from strong celluloid—light and easily cleaned. No rough edges to catch in the hair. Extremely sensitive and free from distortion. All we ask is: TRY THEM SIDE BY SIDE WITH ANY ON THE MARKET—regardless of price. **Each (2500 ohms) $8.50**

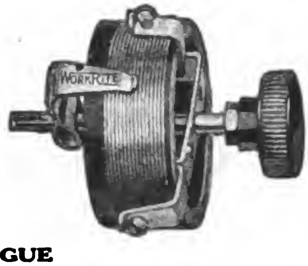


Grasp It On The RIM—

WORKRITE E-Z-TUNE DIAL

When you are tuning in an out-of-town concert and you want to turn the dial of your variometer, variocoupler or condenser the smallest fraction of an inch, where do you grasp the dial? On the rim. That is where the new WorkRite E-Z-Tune Dial has a grip that fits the hand. You can make a turn of a hair's-breadth with this practical dial. Made of the finest material, highly polished and with figures that stand out from the surface, the WorkRite E-Z-Tune Dial at the price listed is extremely cheap. 3½-inch diameter. $\frac{3}{16}$-inch or ¼-inch shaft............................**Price 75c**

50,000 ADJUSTMENTS POSSIBLE
WITH THE WORKRITE SUPER VERNIER RHEOSTAT



Entirely new and very much needed. Indispensable on the detector tube when tuning in long-distance concerts or code. Pushing in knob turns off bulb. Quick adjustment anywhere between 6½ ohms and zero. Turn the knob and get 50,000 different adjustments. All metal fittings made from brass and nickeled. Positively Never Gets Hot. The WorkRite Super Vernier Rheostat is really remarkable in its performance and will double the audibility of distant concerts. **Price $1.50**

SEND FOR OUR FREE CATALOGUE

THE WORKRITE MFG. CO., 5532 EUCLID AVENUE CLEVELAND, OHIO

(Branch Office: 2204 MICHIGAN AVE., CHICAGO)

The most for the money

When a counterfeit is said to be "as good as Brandes" remember that not only is a Brandes *Matched Tone* headset more sensitive, more durable, more comfortable, but that it costs no more.

Painstaking engineering tests have shown that Brandes *Matched Tone* headsets render better and longer service than counterfeits costing more.

Send 10 cents in stamps for the "Beginner's Book of Radio." It explains radio in terms that anyone can understand.

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C. Brandes, INC.

Matched Tone Headsets

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Made in Canada by Canadian Brandes, Ltd., Toronto
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Result of 14 Years' Experience

Dubilier Radio Products
Are Good Enough for Uncle Sam

DUBILIER condensers have long been the standard equipment of the United States army and navy, as well as of the apparatus made by the principal radio manufacturers.

Dubilier Micadons are little *receiving* condensers of *tested mica,* and are made like the condensers ordered by Uncle Sam. They are permanent in capacity and hence reduce tube noises. The price ranges from 35 cents to $1.00 each, depending on the type and the capacity.

No Outside Antenna; No Indoor Loop. Just the Ducon in a Lamp-Socket.

Radio Reception from any Lamp-Socket

The Dubilier Ducon does away with troublesome antennae and loops. Simply screw it in any lamp-socket and the music, news and talks come in perfectly.

Price at your dealer, $1.50.

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DUBILIER
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Canadian General Electric Company, Toronto, Canada

A Real Achievement!

Bel-Canto

The Superlative Loud Speaker

HERE indeed is a *real* achievement—the Bel-Canto Loud Speaker.

The Bel-Canto, both in appearance and performance, is a complete departure from the limitations of the "tin-horn" type of loud speaker. The Bel-Canto is an entirely new instrument constructed on the most advanced principles of acoustic and electrical science.

This new loud speaker embodies such highly developed and revolutionary improvements over ordinary types that, in the opinion of all who hear the Bel-Canto, it is destined to become the standard loud speaker.

For instance, Mr. Paderewski, the great musician, says:

"The clarity and volume of tone, and particularly the absence of sound distortion make it a remarkable device. You are indeed to be congratulated upon your ingenious invention."

When so high an authority as Mr. Paderewski makes such a clean-cut endorsement of Bel-Canto, what more can be said!

We are content simply to explain to you the distinctive features and qualities of the Bel-Cantó and to rest satisfied with your own stamp of approval.

Patent Applied For

1. The Bel-Canto is sturdily constructed of reed and metal on the most perfect of all acoustic principles—the human vocal organs. The sound is purified in a specially constructed chamber before being conducted from the reed amplifying tube to a metal and air-tight resounding chamber. The result is a tone of such clarity and mellowness as to surpass any other amplifying device that we know of—even those selling at $100 or more. Yet the price of the complete Bel-Canto is only $30.

2. Unlike other loud speakers, the Bel-Canto disperses the sound in all directions—filling the entire room.

3. The Bel-Canto is a thing of beauty, of handsome design and beautifully finished in lacquer.

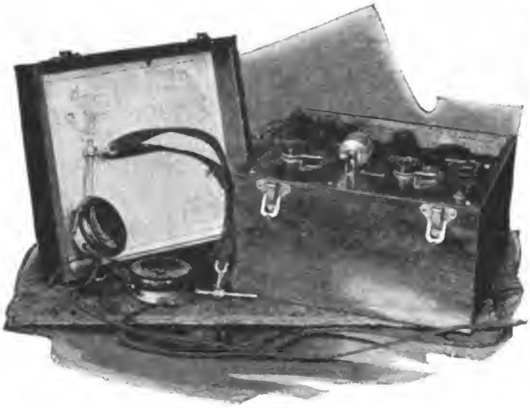
4. The instrument comes complete—fully equipped with a special extra-sensitive loud speaking phone, ample cord and hard rubber plug—all ready to plug into your set. There are no extras to buy and no phones are necessary.

5. The Bel-Canto is fully guaranteed. Entire satisfaction—or we will replace it with a new one provided the plate on the bottom has not been removed.

Although dealers are rapidly placing orders for the Bel-Canto, your dealer may not as yet have been supplied. If this is the case, you may order direct from the factory. Send check or money order for $30, and the complete Bel-Canto Loud Speaker will be shipped to you prepaid and fully guaranteed.

Jobbers and Dealers—Write for our proposition

Bel-Canto Corporation, 417 East 34th Street, New York



Listening Posts of the Nation

THROUGH thousands of De Forest Everyman or Radiohome Receivers the American people are "listening in" on nearby broadcasting stations, adding De Forest honeycomb coils for longer wavelengths, adding De Forest Amplifiers when it is desired to entertain a room-full through loud speakers.

Some rest content with these remarkably efficient and compact but inexpensive sets, others go on to the MR-6 Set, with its greater distance range, or build for themselves, from De Forest parts, sets of greater elaboration. But the thing for you to remember is this: whatever your need—no matter how simply or how deeply you go into radio—De Forest will meet it.

You get from any De Forest apparatus the dependable service which the famous name implies.

De Forest Radio Tel. & Tel. Co.
Jersey City, N. J.

DE FOREST

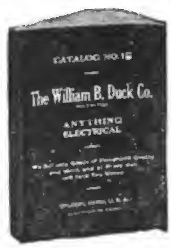
Like the romance of radio itself.

is the story of the phenomenal growth of the company whose name has been linked with radio from the earliest days—Twelve years is a long time in radio—yet over twelve years ago—in 1909, to be exact—William B. Duck began his pioneer work in radio equipment.

Way back in those early days Mr. Duck foresaw with an almost perfect vision the ultimate growth of radio. He was the first and only one to put a "human touch" in a catalog embracing a scientific subject; he realized how largely educational such a catalog must be to accomplish its ultimate purpose—and today, with radio on every tongue, there is in Duck's Wonder Catalog an even larger wealth of practical radio information and diagrams than will be found in any of the earlier editions—***and in language easy for the layman to understand.*** It is little wonder that Duck's catalog is universally known as "The Radio Amateur's Bible."

DUCK RADIO APPARATUS

embraces 62 instruments—58 parts—the largest and most comprehensive line produced by any radio manufacturer. They should be had at all worthwhile retail stores throughout the United States and Canada. In selecting your radio equipment at your dealer's, insist on seeing Duck's products—products that have stood the test of time.



DUCK'S

Big 256-Page

CATALOG

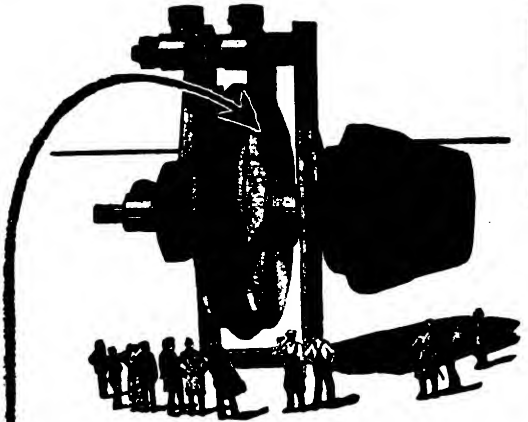
as well as all former editions is now, as in the past, all radio catalogs in one. No other even half so large. It displays not only Duck goods but the products of practically all worthwhile manufacturers and contains more up-to-date and practical radio information than will be found in many text books.

Send 25c in coin for this wonderful book—a retainer that hardly pays the cost of printing.

DEALERS

We offer facilities and advantages not equalled by any other radio house. Write or wire for our proposition.

The WILLIAM B. DUCK CO.
227-229 Superior St., Toledo, Ohio
Established 1909



The Mark of the Master Builder

On every C-H radio rheostat is engraved a guarantee of satisfaction. The familiar C-H trademark, known by engineers the world over as unfailing assurance of electrical and mechanical perfection, today protects the buyer of radio equipment. In these times of uncertainty when so much apparatus offered for sale is the result of hasty development, with insufficient engineering and manufacturing experience, this trademark has even increased value to the purchaser.

Cutler-Hammer, pioneers and largest builders of rheostatic control apparatus, mark with pride these radio rheostats, their latest development.

C-H Vacuum Tube Rheostats for Amplifier and Detector Tube Control

C-H Vacuum Tube Rheostats are made in two styles. Type 11601-H1 is arranged with vernier for detector tube control. This vernier makes it possible to decrease or increase the resistance inserted by infinitesimal amounts for exceedingly great accuracy. One complete revolution of the vernier knob changes the resistance in the circuit by less than .05 ohms. When it is considered that the knob may be turned only a fraction of one degree, it is easily understood what fine control is possible. For amplifier tube control where such great accuracy is not essential, type 11601-H2 is furnished without the vernier feature. Both types are finished in highly polished nickel and are pointer indicating. Cone shaped knobs of genuine Thermoplax are furnished as standard equipment. The rheostats are packed in unit boxes with full instructions and template for easy mounting.

Type 11601-H1, with Vernier $1.50
Type 11601-H2 without Vernier $1.00

For sale at all radio dealers and supply houses. Samples are available direct from factory at list price plus ten cents for carriage.

THE CUTLER-HAMMER MFG. CO.
Milwaukee, Wisconsin

CH **FILAMENT CONTROL**

HOMCHARGE

your **RADIO BATTERY** *for* **A NICKEL**

No muss, trouble, dirt—no moving of batteries—loss of time—no technical or professional knowledge needed. May be used right in your living room.

THE RADIO HOMCHARGER DE LUXE

charges your "A" or "B" battery over night and is the only rectifier on the market combining the following essential HOMCHARGING features:

1—Simplicity itself—attach to any lamp socket and connect battery.

2—Self-polarizing. Battery may be connected either way and will always charge.

3—Fully automatic in operation—gives taper charge—cannot overcharge or injure your battery.

4—Safe. All parts entirely enclosed. No danger from fire. APPROVED BY UNDERWRITERS EVERYWHERE.

5—Constructed of the best material—genuine Bakelite Panel, Jewell Ammeter, closed Core Silicon Steel Transformer. No castings used, only the best stampings throughout. UNQUALIFIEDLY GUARANTEED.

6—No delicate bulbs to break or burn out. Only one moving and two wearing parts, replaceable as a unit, at small cost.

AN ORNAMENT FOR YOUR LIVING ROOM

Beauty has been combined with utility in the NEW RADIO HOMCHARGER DE LUXE. The body is beautifully finished in mahogany and gold. Equipped with rubber feet, it cannot mar polished surfaces. It harmonizes with the finest living room.

Furnished complete. No extras to buy. Price, $18.50 at all good dealers, or shipped prepaid upon receipt of purchase price.

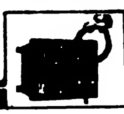
Booklet illustrating the NEW RADIO HOMCHARGER DE LUXE in actual colors is FREE for the asking. Send for your copy today.

DEALERS—JOBBERS: Over 150,000 HOMCHARGERS will be sold this fall and winter. Send for "HOMCHARGER Business Builders" and Discounts and see how you can get your share of this business.

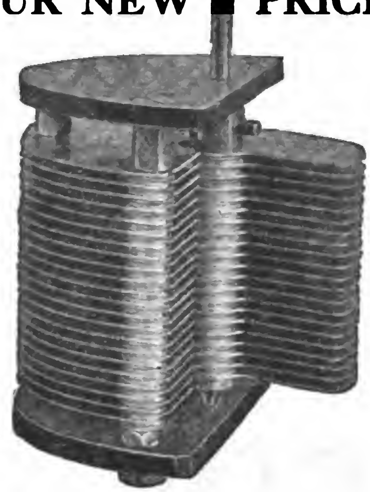
The Automatic Electrical Devices Company

132 West Third St. - CINCINNATI, O.

Largest Manufacturers of Vibrating Rectifiers in the World



Compare
OUR NEW PRICES



UNION-RADIO
Variable Condensers
(Panel Mounting Type)

Union Radio Variable Condensers are as nearly perfect as modern machinery and human skill can make them. For quality in materials, workmanship and performance they stand unequalled.

We have spared no expense to make these guaranteed variable condensers perfect. Now you can get them at

OUR NEW PRICES

13-Plate.....$2.50—(With Dial).....$3.50
23-Plate.....$3.00—(With Dial).....$4.00
43-Plate.....$3.75—(With Dial).....$4.75

The *plates* are of polished 100% hard aluminum. The separators are made of brass, accurately machined insuring uniform spacing. The *shaft* $\frac{3}{16}$-inch hard brass nickel (no iron or steel to cause eddy losses). *Bearings* are adjustable to both alignment and friction. The tops and bottoms are machined Dark Red Radion, which has an extremely high insulation factor and is very resistant to heat and moisture. The *connections*—soldering lugs are provided and positive connection to the rotary plates is insured at all times, doing away with any chance of noisy operation. Stop pins are provided allowing 180-degree revolution of the plates. Pins are removable.

We manufacture Receiving Sets, Two-Step Amplifiers, Vacuum Tube Receptacles, Condensite Dials, Filament Rheostats, Telephone Tip Jacks and Variable Condensers.

Write now for your copy of our catalogue, "Radio Apparatus A"

Retailers and Wholesalers

Samples of our guaranteed, reasonably priced "Quality Products" sent on request. Our terms and trade discounts are liberal. Write for our proposition and catalogue.

UNION-RADIO-CORPORATION
200-MT. PLEASANT-AVENUE,-NEWARK-N.J.
NEW-YORK-OFFICE — 116-WEST-32nd-STREET.

ECONOMICAL "A" BATTERY

The Magno Storage Battery is the most economical "A" Battery on the market today. It is of practically unlimited ampere hour capacity because it can be

Recharged at Home in 1 Minute

Simply unscrew cover and insert "spare" charged electrode. "Spares" are exchangeable at your dealer's or from us at 25 cents each. Thus, you see, expensive

Charging Equipment Not Needed

"Spare" charges can be kept indefinitely. They will not "run down" prior to insertion in the battery. They need no more care than a hammer. By keeping "spares" on hand your concert will never be interrupted.

Each Magno Battery is a 2-volt unit. Two in series is sufficient for the new 4-volt tubes. Three in series for the 6-volt tubes. Each positive electrode is rated at 30 ampere hours, but because of their unusual recuperative power they last much longer than their rated capacity.

You can get a greater ampere hour capacity with Magno batteries and a few "spares" per dollar invested than from any other battery. And with Magnos maintenance costs are practically nothing.

Write for descriptive folder.

Magno Storage Battery Corp.
Aeolian Bldg., New York City

STORAGE BATTERY
MAGNO

One-Three-Five Years from Now?

TIME and use are the great laboratory tests for radio telephone receiver quality. What will *your* head-set be worth after months and years of use? Will the steel still retain its magnetism? Will the assembly still exhibit that accuracy so necessary to the critical needs of radio? Will the tone and volume still have those finer qualities that they possessed in their newness and youth?

Will YOUR head-set be in service one year from now? Three years from now? Five years from now?

-here's what one user has to say of-"Red-Heads"

The Newman-Stern Company
Cleveland, Ohio

Dear Sirs:

I have a pair of your "Red-Head" receivers purchased about three years ago.

I have carried them with me over 20,000 miles; in suitcase or sea-bag whenever they were not on the table or thrown into the drawer.

They have been dropped on steel decks during rough weather; thrust on the table with a bang when the static was exceptionally annoying.

In fact, they have come through the hardest kind of hard service. They are scratched and nicked all over, but I am happy to say they are still on the job, and as clear-toned as ever.

Yours very truly,

THE goodness and efficiency of "Red Head" Receivers is not a matter of accident. They were designed by skilled radio engineers who understood what was needed to make the right kind of radio 'phones—the kind that would *stay* right. In the seven years that they have been on the market, "Red Heads" have come into use the world over.

At the new low price of $6.50, they are unquestionably the biggest value on the market today in 3000-ohm, aluminum back receivers.

You take *no risk* when you buy "Red-Heads." We guarantee them *absolutely*. Your money back if you are not satisfied.

RED-HEADS'

A Triumph in Radio Receiver Design

-NOW $6.50

At your dealer's or sent direct on receipt of price.

The Newman-Stern Co

Newman-Stern Bldg., CLEVELAND, OHIO

Producers of "Red Head" radio receivers, "NAA" Arlington Tested Detector Crystals and the Teagle line of *better* radio apparatus. Send for descriptive bulletins.

DEALERS: The Newman-Stern Co. is a pioneer radio organization. The radio instruments we put out have gained a wide reputation. It will pay you well to write for our dealer proposition.

THE NEWMAN-STERN CO.
CLEVELAND, OHIO

Gentlemen:—Enclosed is Money Order for $6.50 for which please send me a pair of "Red Head" Receivers. It is understood that if I am not completely satisfied with these 'phones, I may return them within seven days and get my money back.

Name ______________________

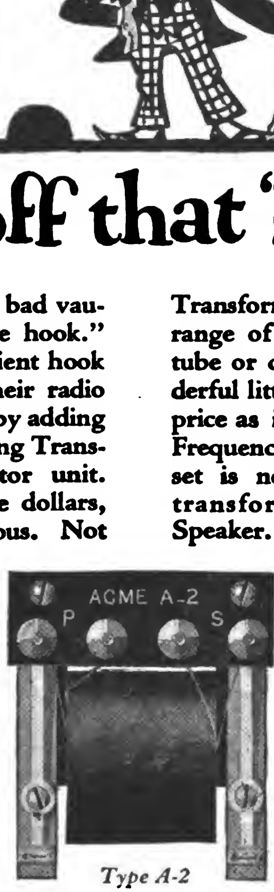
Post Office Address ______________________

The name of my dealer is ______________________

Choke off that "squawk"

AFTER all it is not always the bad vaudeville actors that "get the hook." Many owners have found an efficient hook to choke off the "squawk" of their radio sets and secure enjoyable music, by adding Acme *Audio* Frequency Amplifying Transformers to the ordinary detector unit. Acme Transformers cost but five dollars, yet the results are almost marvelous. Not only do they amplify sound, but they bring it naturally—realistically. They are necessary to the proper operation of the Acme Clear Speaker which enables a whole roomful of people to enjoy the broadcasting concerts.

In order to get more than one broadcasting station and thereby pick out the concert you like best, you should also add an Acme *Radio* Frequency Transformer. This greatly increases the range of your set whether it be vacuum tube or crystal detector type. This wonderful little transformer sells for the same price as its twin brother, the Acme *Audio* Frequency Amplifying Transformer. Your set is not complete without both these transformers and the Acme Clear Speaker.



Type A-2
Acme Amplifying Transformer
Price $5 (East of Rocky Mts.)

The Acme Apparatus Company (pioneer transformer and radio engineers and manufacturers) also make detector units, the Acmefone, Acme C. W. and Spark Transmitters, etc. Write for interesting Transformer booklet if your own radio or electrical dealer cannot supply you.

The Acme Apparatus Company, Cambridge, Mass., U. S. A. New York Sales Office, 1270 Broadway.

ACME

for amplification

The Only Knob and Dial Without a Set-screw

Patented June 20, 1922.

The unsightly and troublesome SET-SCREW is at last eliminated. No more splitting the head of the set-screw or stripping of threads, perhaps ruining the dial.

To mount the TAIT-KNOB-AND-DIAL simply hold the dial with one hand and screw on the knob with the other; a few seconds does it. No tools are necessary. When fastened it is self centering and self aligning.

This beautiful patterned KNOB-AND-DIAL is made of the best grade of BAKELITE.

To those building their own sets—Don't fail to use this dial, it is REVOLUTIONARY in its field and is the PEER of all KNOBS-AND-DIALS. If your dealer has none, write us and we will refer you to one who has.

Dealers—If your Jobber is not stocked up, write us and we will refer you likewise.

List price—4" model $1.50; 3" model $1.00

We Sell Strictly to Manufacturers and Jobbers—whom we invite to write us for samples and discounts.

TAIT KNOB & DIAL COMPANY, Inc.
11 East 42nd Street Dept. P. New York

Get Your Radio Supplies from Headquarters—that's "Chi-Rad"

DISTRIBUTORS FOR

- American Radio & Research Corp.
- Acme Apparatus Co.
- Adams-Morgan Co.
- C. Brandes, Inc.
- Burgess Battery Co.
- Clapp-Eastham Co.
- DeForest Radio Tel. & Tel. Co.
- Federal Tel. & Tel. Co.
- General Radio Co.
- Wm. J. Murdock Co.
- Wireless Press, Inc.
- Chelsea Radio Co.
- A. H. Grebe & Co.
- Radio Corp. of America
- Thordarson Elec. Mfg. Co.
- Remler Radio Mfg. Co.
- Westinghouse Elec. & Mfg. Co.
- Pacent Electric Co.
- Electrical Research Laboratories
- Mu-Rad Laboratories, Inc.

It will pay you to connect with the firm acting as distributor for most of America's reliable radio equipment manufacturers. Avoid the necessity of "shopping around" for your supplies.

We can give you immediate service on equipment manufactured by the firms whose names appear at the left.

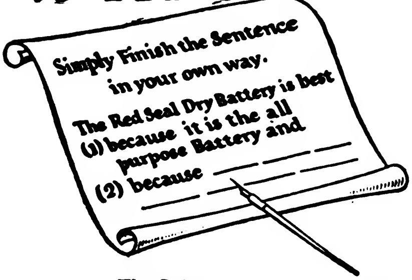
Send for your free copy of our new catalog showing our extensive lines of standard radio equipment.

As a means of getting acquainted, we offer a copy of Cram's Radio Map, regular price 35c, for this ad and 15c

Chicago Radio Apparatus Co., Inc., 415 South Dearborn St. CHICAGO, ILL.

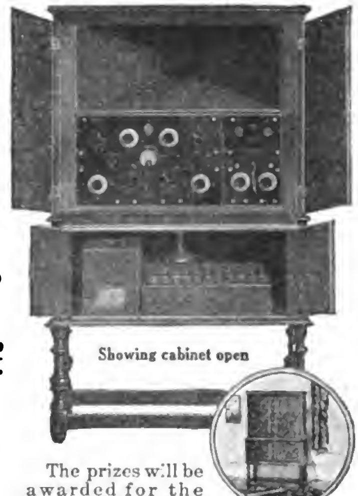
Starts Nov. 1st Red Seal Battery Contest Closes Nov. 15th

For the Best Answer to THIS-



You Win THIS $725.00 Complete Radio Set-Free

Hears broadcasted concerts 400 to 600 miles away; receives wireless telegraph from Europe, South America, from ships on the high seas, etc.



Showing cabinet open

The prizes will be awarded for the most appropriate answers completing *in your own way*, in not more than ten words the following sentence:

The Red Seal Dry Battery is best—
1. because it is the all-purpose battery, and
2. because......................

Important:—Only those answers written on the official Contest Blanks will be considered. Mail as many answers as you like to: Red Seal Battery Contest, Manhattan Electrical Supply Co., Inc., 17 Park Place, New York City.

The Prizes

It is appropriate that the Manhattan Electrical Supply Company should be the first to offer such Radio Sets as these. This company was one of the pioneers in selling radio, as well as being the manufacturer of Red Seal Dry Batteries used so successfully in connection with radio sets.

First Prize—$725.00 Complete Kennedy Radio Set

This Cabinet Type complete Radio Receiving Set is one of the finest and most up-to-date receiving sets yet produced. The cabinet is walnut and stands 58 inches high. Range from 400 to 600 miles for wireless telephone and 2,000 to 3,000 miles for wireless telegraph. Contained within the cabinet are all batteries, "Radio Homcharger de Luxe" battery charger and Magnavox loud speaker with special horn. Installed free, in the home of the winner.

Second Prize—$408.50 Complete Westinghouse Radio Set

It consists of the Westinghouse R. C. Receiving Set and Western Electric Loud Speaker, "Tungar" Battery Charger, Storage Battery, "B" Batteries, Set of Manhattan 3,000 ohm Headphones, 3 vacuum tubes, 2 telephone plugs and complete antenna equipment. Installed free in the home of the winner.

Third Prize—$256.50 Complete Grebe Radio Set

A complete receiving outfit made up of the well known Grebe C. R.—9 Regenerative Receiver with Two Stage Amplifier, Magnavox Loud Speaker, Storage Battery, "Radio Homcharger de Luxe" battery charger "B" Batteries, set of Manhattan 2,000 ohm Headphones, 3 vacuum tubes, 2 telephone plugs and complete antenna equipment. Installed free in the home of the winner.

50 Other Prizes

To each of 50 other contestants whose answers are meritorious will be given one of the famous Manhattan 2,000 ohm Radio Headsets. These headsets have great sensitiveness and high amplifying qualities.

How to Enter the Contest

Simply follow the instructions on the Contest Blanks given away by stores all over the U. S. A. Nov. 1 to Nov. 15. You will recognize these stores by the Red Seal Window Display pictured below.

Look for this Window Display in Dealers' Windows Nov. 1 to Nov. 15, It identifies Dealers who will give you free Contest Entry Blanks.

The Judges

The winners will be selected by the following Judges: Mr. Llew Soule, Editor of "*Hardware Age*," New York; Mr. Howard A. Lewis, Manager of "*Electrical Merchandising*," New York, and Mr. Joseph A. Richards, President, Joseph Richards Co., Inc., Advertising Agents, New York.

Announcement of Winners

The names of the winners will be published in the *Saturday Evening Post* as soon as possible after the contest closes.

In case two or more persons submit winning answers, prizes identical in character with those offered will be given to each successful contestant.

Important to Dealers

Duplicates of these 53 prizes are to be given to dealers having the BEST CONTEST WINDOWS. Write us at once for full information and free window display material if you haven't already done so.

MANHATTAN
ELECTRICAL SUPPLY CO., INC. NEW YORK
Makers of the Famous Red Seal Dry Batteries and Manhattan Head Sets

CUT ME OUT!

Would you like to turn your spare time into cash profits? As a subscription representative of POPULAR RADIO you can very easily earn Christmas money simply by telling your friends about the best radio monthly for the least money.

Fill in and mail the attached coupon to us today.

- - - - - - - - - - - - - - - - - - - -

POPULAR RADIO,
9 East 40th Street,
New York City.

Please tell me about your plan to make Christmas money by acting as a subscription representative of POPULAR RADIO in my spare time.

Name ....

Address ....

City........................ State..............

Is Your Receiver Heard 500 Yards Away?

Here are choke coils and resistances for use in the Armstrong Super-Regenerative Circuit that produce real results. Note the quotation from this letter:

> I am in receipt of the choke coils and resistances for use in the Armstrong Super-Regenerative which were shipped by you on August 11th. Am pleased to state that I tried out this circuit last evening, using a 30" loop and the reception from WWJ, WJZ, KDKA, WSB and several other broadcasting stations was remarkably strong; in fact, entirely too strong for head phones. Using 90 volts on the regenerator and oscillator tubes and a total of 135 volts on the amplifier tube, and with a Western Electric loud speaker the musical programs could be heard a distance of 500 yards.
>
> Yours very truly,
>
> (Signed) W. C. HUTCHISON,
>
> Windrock Coal & Coke Co., Windrock, Tenn.

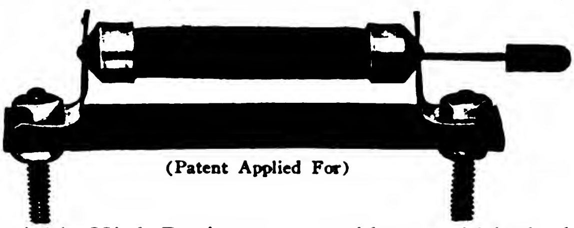
These choke coils are the correct value for use in the filter circuit of Armstrong's famous receiver.

Other Parts for the Armstrong circuit. Prices:

5 Millihenri Coils	**$2.50**
100 Millihenri Coils	**3.00**
12,000 Ohm Resistance, Wire Wound and Non-Inductive	**3.00**
1,250 Turn D.L. Coils	**3.00**
1,500 Turn D.L. Coils	**3.30**
.0025 Micon Condensers	**.50**
.005 Micon Condensers	**.75**
Variocouplers—Especially Wound	**7.00**

SOMETHING NEW IN GRID LEAKS!

THE DURHAM VARIABLE HIGH RESISTANCE



(Patent Applied For)

The Durham Variable High Resistance provides a grid leak that is **adjustable** over a wide range and will maintain its value permanently after an initial setting. It is non-inductive and has negligible capacity.
It is made in two sizes as follows:—

No. 100—1,000 to 100,000 ohm range.
No. 101—100,000 to 5,000,000 ohm range.

These resistances are made to fit any standard grid leak base. The Durham base can be furnished if desired.

Retail Prices: Variable High Resistance without base, **75c**; base, **40c**. Attractive discounts to dealers and jobbers and immediate shipment. For further details and other uses write:

DURHAM & COMPANY

RADIO ENGINEERS

1936 MARKET STREET **PHILADELPHIA, PA.**

35c each 3 for $1.00

Na-ald

Genuine CONDENSITE DIAL

The dial that runs true

Numerals engraved on bevel and knob so shaped that fingers do not hide them. Thin edge with clear graduation to make accurate reading easy. Concealed set screw in metal insert. Will not warp or chip. Finish and enamel permanent.

Low price with this quality possible only through quantity production.

Special dealer and jobber proposition. An opportunity

ALDEN-NAPIER CO.
Dept. C 52 Willow St., Springfield, Mass.

Speed Up Your Production

by sawing bakelite, formica, brass, copper, carbon, or wood on a

Junior Bench Saw

A precision machine especially adapted to the rapid and accurate production of small duplicate parts. All metal construction. Top 10" x 13", elevates for grooving, tilts 10 degrees for beveling. Saws 1½" stock. Easily driven by ¼ hp. or ⅓ hp. motor. Attachments for grinding and sanding. Special saws for bakelite, brass, etc., furnished from stock.

Junior Bench Saw with guides and one 6" wood saw **$28.75**

Motor Driven Unit as shown, mounted on iron base with ¼ hp. ball-bearing motor, belt tightener, belt, cord, plug, and switch, $60.00. Write for fully illustrated circular.

Manufacturers and amateurs will be interested in our Handilathe, Junior Bench Drill, Handisaw and Ball-Bearing Motors.

W. & J. BOICE, Dept. 611, 114—23rd ST., TOLEDO, OHIO

MAKE YOUR OWN RADIO RECEIVING SET

ENJOY the concerts, baseball scores, market reports, latest news, etc., as sent out by large broadcasting stations. This NEW copyright book, "EFFICIENT RADIO SETS," shows how to make INEXPENSIVE set for receiving wireless broadcastings. Sent postpaid for 25c. Address

J. C. Dorn, Pub., 725 S. Dearborn St., Dept. 110, Chicago.

The "COPPER GIANT" "B" Battery

is guaranteed for two years

in ANY receiving set because it does not deteriorate while standing idle. This is a very large battery designed for stationary and semi-portable installations where absolute reliability over a period of years is the first consideration. Standard voltages—22, 50 and 100. Any voltage made to order. Write for illustrations.

J. A. RITTER. -:- LANSDOWNE, PA.

Vacuum Tubes Repaired

All makes of six-volt Detectors and Amplifiers repaired equal to new.
Work is guaranteed satisfactory on a money-back basis.
Special proposition to agents.

CURTISS RADIO COMPANY
Office: 126 South Eighth Street Newark, N. J.

BAKELITE-DILECTO PANELS

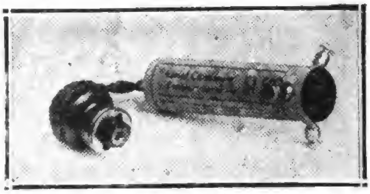
Genuine Bakelite-Dilecto panels are specified by our Navy. They are the best obtainable and Tuex sells them at the lowest prices. Standard panels 3/16 in. thick, very accurately cut with smooth, square edges will cost you:

6x 7 ea. $1.05	6x18 ea. $2.25	7x10 ea. $1.50	12x14 ea. $3.50
6x12 ea. 1.50	6x21 ea. 2.60	7x12 ea. 1.75	12x18 ea. 4.50
6x14 ea. 1.75	9x12 ea. 2.25	7x18 ea. 2.65	12x21 ea. 5.20

Other sizes: ⅛ in. thick, 2c per sq. in.; 3/16 in. thick, 3c per sq. in.; ¼ in. thick, 4c per sq. in.
Shipped C. O. D. or postpaid upon receipt of check or money order. Satisfaction guaranteed.

TUEX SUPPLY CO., 1124 STATE STREET BRIDGEPORT, CONN.

THE WIRELESS WONDER



A Complete Aerial for **$1.50**

Simply screw in any lamp socket and turn key on. Better than an outdoor aerial. Nothing to get out of order. Eliminates lightning danger. Money back guarantee.

Radio Catalog FREE at your dealer's or

STEINMETZ WIRELESS MFG. CO.
5706 Penn Ave., Pittsburg, Pa.
ELECTRICAL ENGINEERS AND MANUFACTURERS

Commercial Radio

An interesting profession that takes you to all parts of world. Prepare through a school with a reputation for efficiency. Arc, spark and tube. Day and evening classes. Positions guaranteed.

Send 10 cents in stamps for catalog

COMMERCIAL RADIO INSTITUTE
10 East Centre Street Baltimore, Md.

AGENTS—Auto Free

We need special agents to travel by Automobile introducing our great line of Nationally-advertised Pure Food Products, Soaps and Household Necessities. Here is an opportunity to earn $6 to $12 a day, all or spare time and obtain an Automobile FREE besides. Write at once for full particulars. Address

AMERICAN PRODUCTS CO.
7299 American Bldg., Cincinnati, O.

JOY-KELSEY CORPORATION

Manufacturers
RADIO EQUIPMENT
4021 West Kinzie St. Chicago Ill.

TUSKA RADIO

Reliable in Service —:— Moderate in Price

THE C. D. TUSKA COMPANY
Bartholomew Ave., Hartford, Conn.

SELL US YOUR SPARE TIME

You can turn your spare time into cash profits simply by acting as a subscription representative for POPULAR RADIO. If you want to make your spare hours yield you a real profit, write to **POPULAR RADIO, 9 East 40th Street, Box 171**

A Radio Achievement

of Low Cost and High Efficiency

Type D	**Type E**
Tuner-Detector	**2 Stage Amplifier**
$20.00 list	**$25.00 list**

With the Man-Day combination receiver, Newark, Pittsburgh, Schenectady, and Detroit are heard consistently at Lynbrook, L. I. At Cincinnati, the Man-Day picks up Newark, St. Louis, Columbia, Missouri, Louisville, Ky., and many nearby stations. At Kansas City the Man-Day receives Denver, Atlanta, Sioux City, and points in Canada.

The set can be loaded up to 20,000 meters. The receiver, Type D, can be used alone and the two-step amplifier, if desired, may be purchased at any subsequent time. This increases the range and strength of signals.

Five day return privileges in the event that our outfits do not come up to every claim we make.

We offer opportunities for additional dealers and jobbers.

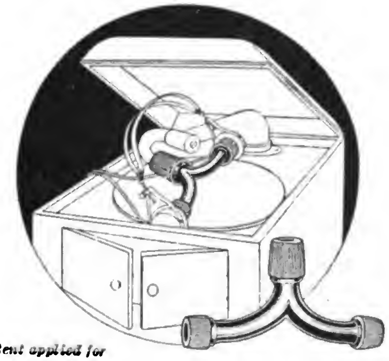
MAN-DAY RADIO CORP'N

135 *West* 33*rd St.*, *New York City*

BRANCH: Lynbrook, Long Island

PHONOTACH
Makes Your Phonograph a Radio Loud Speaker

(Trade Mark)
Adjust it in a minute.



Patent applied for

A New and Better Loud Speaker
at a very low cost

The PHONOTACH connects the receivers with the tone arm of your phonograph

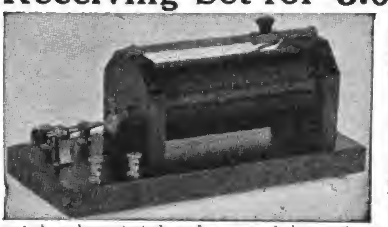
Utilizes the scientifically designed tone amplifier of the talking machine to secure mellowness and beauty of tone.

Price only $2.00

Send for one today—At your dealer, or by mail.
W. A. MILLS,
103 Park Ave., New York, N. Y.

A Receiving Set for $3.00

S I M P L E



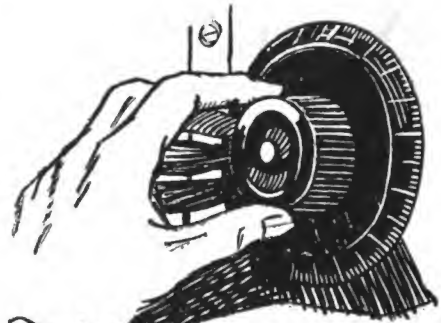
E F F I C I E N T

This set has been tested and approved by engineers of Popular Radio, and has our guarantee for a radius of at least 25 miles from stations broadcasting concerts.
This set with 1200 ohm single headphone..........$5.00
For further particulars send for illustrated circular.
RITTER RADIO CORPORATION, 232 Canal St., New York City

Na-ald
De Luxe
V. T. Socket

Contact strips of laminated Phosphor bronze press firmly against contact pins, regardless of variation in length. No open current trouble possible. Socket moulded from genuine Condensite. Practically unbreakable. Special protected slot, with exterior reinforcement. Unaffected by heat or bulbs or soldering iron. All excess metal eliminated, aiding reception. May be used for 5 Watt power tube. Highest quality throughout. Price, 75c.

Special proposition to dealers and jobbers.
ALDEN - NAPIER CO.
52 Willow St. Dept. C Springfield, Mass.



How to stop noises when you touch dials

Have you ever noticed in tuning a radio receiving set that when you touch dials, knobs or switches it causes a humming or whistling noise? It is annoying, isn't it? These distracting sounds will disappear if you install dials, knobs and other parts made of

RADION

Tests by disinterested laboratories have shown conclusively that RADION is without exception the best material for radio parts and panels because it comes closest to being the perfect insulation.

Have you tried RADION? If not, secure a dial or other part from your dealer today. Take it home and experiment—that's the best way to become convinced of its unusual qualities.

And while at your dealers, ask him to show you a RADION Mahoganite panel. Its beautiful mahogany grain will please you. It won't warp and is easy to work. If your dealer cannot serve you, write us direct for all information giving us his name.

Dealers Are Invited to Write for Lists

American Hard Rubber Company
11 Mercer Street New York

How do you buy Your Radio Batteries?

DO YOU SAY to a jeweller, "I want a watch!"—or do you ask for a specific watch that does well what watches must do *well?*

And so with batteries for radio.

Most of the noises attributed to static and other causes are *battery* noises. They are caused by irregular current discharge—"fluctuating" voltage.

Have you ever noticed how electric lights *flicker* in some localities —enough to make reading impossible?

Just so, ordinary batteries send out *fluctuating* currents, which make *hearing flicker!*

Radiobats "A" and "B" give absolutely *steady* voltage. They eliminate "interference" because they never produce it. They cut out "static" because *they* don't produce sounds *like* static.

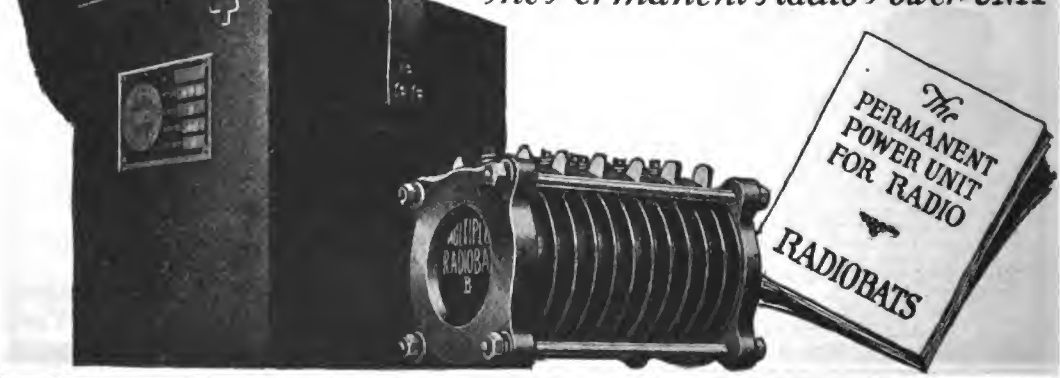
George Gaynor Hyde, one of the foremost consulting engineers in Radio reports, " . . . . . . total absence of any noises such as are common to the usual type of "B" batteries. In fact when the antenna wire was removed from the set, it was almost impossible to tell whether the remaining apparatus was working or not."

With Radiobats "A" and "B" one adjustment lasts *all* evening; screeches and screams become splendid harmony; hisses become the most enjoyable music; grating, rasping gasps become clear, melodious human voices.

Send for our intensely instructive booklet—free—and send us the name and address of your dealer, so that he may give you the finest radio demonstration you have ever heard. Send for it now.

MULTIPLE STORAGE BATTERY CORPORATION
350 Madison Avenue, New York

"A" and "B" RADIOBATS
The Permanent Radio Power-UNIT

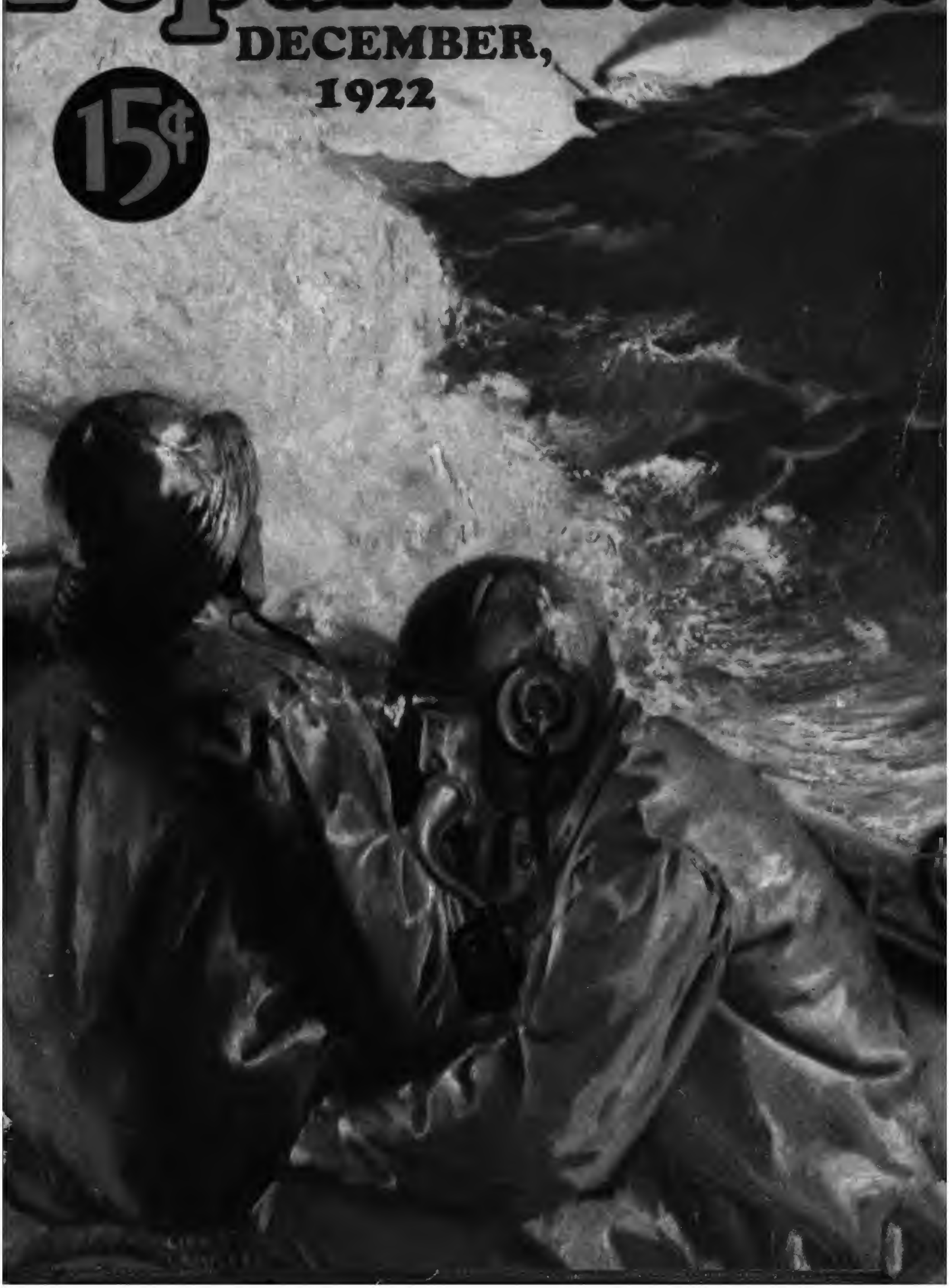


CHARLES FRANCIS PRESS, NEW YORK

Popular Radio

DECEMBER, 1922

15¢



POPULAR RADIO

EDITED *by* KENDALL BANNING

CONTENTS *for* DECEMBER, 1922

(Cover design by Gerald Leake)

VOLUME II NUMBER 4

DEPARTMENTS

VOLUME II DECEMBER, 1922 NUMBER 4

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E. E. FREE, Ph.D., *Contributing Editor* LAURENCE M. COCKADAY, R.E., *Technical Editor*

A Page with the Editor

Every radio fan knows—or *ought* to know—what the "Heaviside Layer" theory is and how it affects radio waves. If he doesn't, he may turn to page 231 and find out. Dr. Elihu Thomson there states that the theory is invalid, and gives his reasons. In the January issue Sir Oliver Lodge states that the theory is perfectly good, and also gives his reasons.

* * *

Thus another international argument is precipitated!

* * *

The broadcasting of the side-line reports of the World-Series baseball games at the Polo Grounds in New York—thanks to the timely cooperation of the Western Union Telegraph Company—was not only a treat to hundreds of thousands of radio fans, but also a stimulant to the radio industry as a whole. As this issue of Popular Radio goes to press negotiations are pending for broadcasting side-line reports of the big football games of the East. Only failure to obtain the necessary wires from the athletic fields to the broadcasting stations will prevent the plan from being carried into effect.

* * *

"I am a crippled soldier and have been in the hospital since December, 1919," writes Cyril A. Newman (Serial No. C—613,886) from the Mercer Hospital at Trenton, N. J. "I won't be able to leave the Government's care for some years. Can you help me get a radio outfit to help pass the time? I haven't any money with which to buy one—but I'm radio crazy."

* * *

Through the generosity of a Popular Radio reader, veteran Newman's request has been granted. But his plea has given the Editor an idea. Why not send discarded radio sets to other invalids in other hospitals?

* * *

Radio sets forwarded to the office of Popular Radio will be distributed among disabled veterans without charge—and after investigation of each case.

Where could a radio set be located to better advantage than at a cripple's bedside?

* * * *

"We have been advertising in six of the leading radio papers, and have had our advertisements keyed," writes H. M. Linter of the Teleradio Corporation of New York. "We find that we get two replies from Popular Radio to only one from *all the other five publications combined.*"

* * *

Those are strong words, Brother Linter! But you are not alone in your experience with Popular Radio's advertising pages. Here, for example, is what S. J. Grossman, of the Man-Day Radio Corporation, writes:

"Dollar for dollar, your magazine has brought in returns far better than any other publication—and we advertise only in the best magazines."

* * *

The letters quoted above are but typical of dozens. They are of peculiar interest to the Editor because they indicate that Popular Radio is actually reaching the class of reader at which it is aiming—the radio novice and the radio amateur.

* * *

Ever since the successful broadcasting of the New York Philharmonic concerts last summer, Popular Radio has been making efforts to arrange for the broadcasting of additional concerts this winter by the same great orchestra. As this number goes to press it appears that this project will be accomplished. Important as this undertaking is in itself, it is but part of a great nation-wide program which this magazine is working—and working hard—to build up for the benefit of radio fans and of the radio industry.

* * *

"Your November number," writes Dr. William H. Easton of New York, "contains two remarkable features. One is the first intelligible description of the Relativity Theory, in Sir Oliver Lodge's contribution; the other is the first simple, clear-cut description of the action of a regenerative receiver in John V. Hogan's article."

Our own ideas exactly!

* * *

"I could go on for page after page of tribute to Popular Radio and still not say enough," writes Frank Feigle of New Kensington, Pa., at the conclusion of a letter. "We radio old-timers need your magazine as letters need stamps."

The Editor can add only the hope that they will be as inseparable.

* * *

With this issue Popular Radio introduces to its readers a new member of the editorial staff—George B. Chadwick, captain of the famous 1903 Yale football team, editor, officer in the World War and for the past three years Director of Publications of the American Red Cross, National Headquarters, Washington, D. C. Mr. Chadwick is taking over the duties of Managing Editor.

Kendall Banning

Editor Popular Radio

From a photograph made for POPULAR RADIO

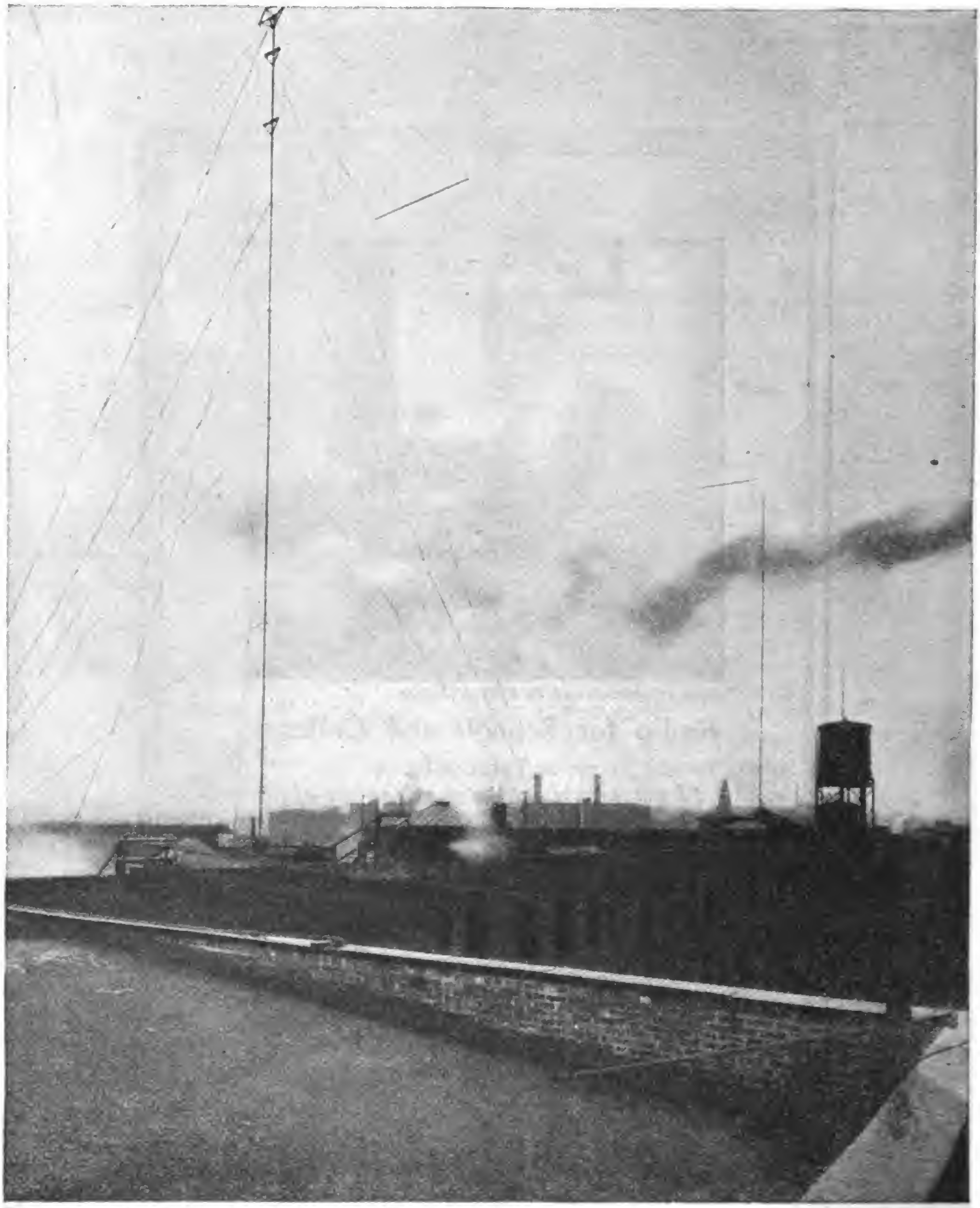
Radio for Schools and Colleges

TO THE EDITOR OF POPULAR RADIO:

"I am greatly interested in the use of the radio for educational and cultural purposes. . . . I am hoping that we may be able to do some work of this description shortly."

Jno. J. Tigert

COMMISSIONER OF EDUCATION
OF THE UNITED STATES



From a photograph of WJZ Station made for POPULAR RADIO by Westinghouse

The Advance Agent of the New Era

¶ *"We have as yet but caught a glance of the social destiny that radio will fulfil. . . . It will achieve the task of making us think together, feel together, act together, not merely as a nation but as a world!"*

—SEE PAGE 236

Popular Radio

VOLUME II DECEMBER, 1922 NUMBER 4

Is the "Heaviside Theory" Valid?

The Answer in the Negative, by DR. ELIHU THOMSON
The Answer in the Affirmative, by SIR OLIVER LODGE

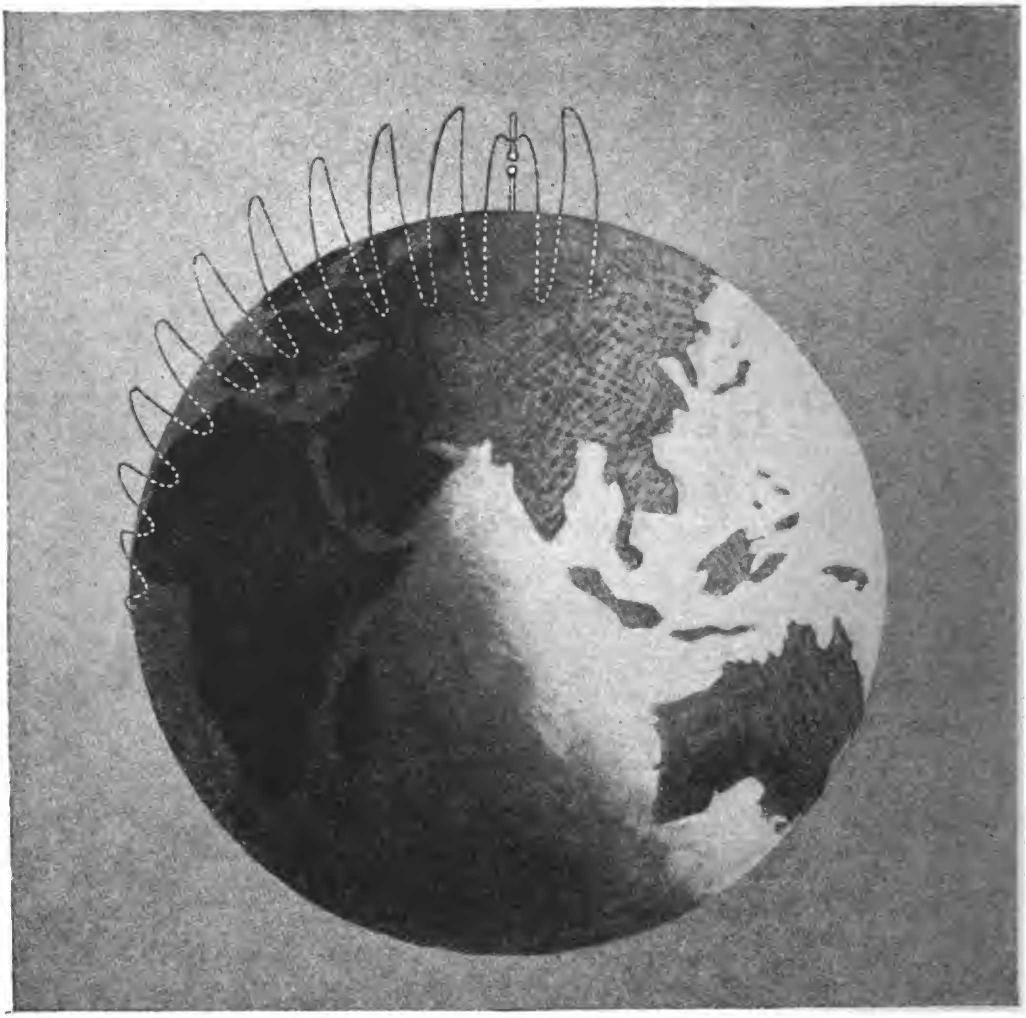
FOREWORD

WHEN Marconi's historic feat of transmitting signals across the Atlantic by means of "wireless" was established as a fact, a group of eminent scientists cast about for a theory that would explain how the radio waves were sent around the curvature of the earth. According to notions conceived up to that time, light waves and radio waves traveled only in straight lines. To explain this new phenomenon, therefore, a theory known as the "Heaviside layer theory" was evolved. This theory presupposes a spherical layer of ionized gas or minute conducting particles of matter, suspended about fifty miles above the surface of the earth; this layer is presumed to serve as a reflector and to bend or deflect the radio waves and thus send them around the earth in a circular path. Another group of no less famous scientists, however, emphatically deny the validity of this theory. They explain the phenomena by means of the "gliding wave theory," according to which the waves are led around the curvature of the earth by ground conduction. This latter theory is upheld by the distinguished American scientist, Dr. Elihu Thomson, who was one of the first great experimenters in this field. The other side of this discussion will appear in this magazine for January—written by the eminent English scientist, Sir Oliver Lodge.—EDITOR

BY ELIHU THOMSON, PH.D., SC.D.

WHEN Marconi brought out his system of wireless telegraphy about 1896, it was at first thought by most scientists or physicists of the time that it was a plain case of the sending out of waves of the Hertzian type, which Dr. Heinrich Hertz had so ably investigated ten years before. If such were the case, the transmission was necessarily in straight lines from the oscillator; necessarily, also, such waves could not follow the curvature of the earth's surface, but they must leave the earth as if they were light beams—another case of electromagnetic waves moving in a straight course.

There were some of us, however, who, taking into account the grounding at the base of the antenna, recognized the fact that the Marconi transmission was not made by real Hertzian waves, but on account of the grounding, by half-Hertzian waves only, and that the Marconi oscillator or antenna system was a half-oscillator only. From this it followed that the waves were in reality attached to and guided by the earth's surface, and particularly by the sea surface, more conductive than the land.

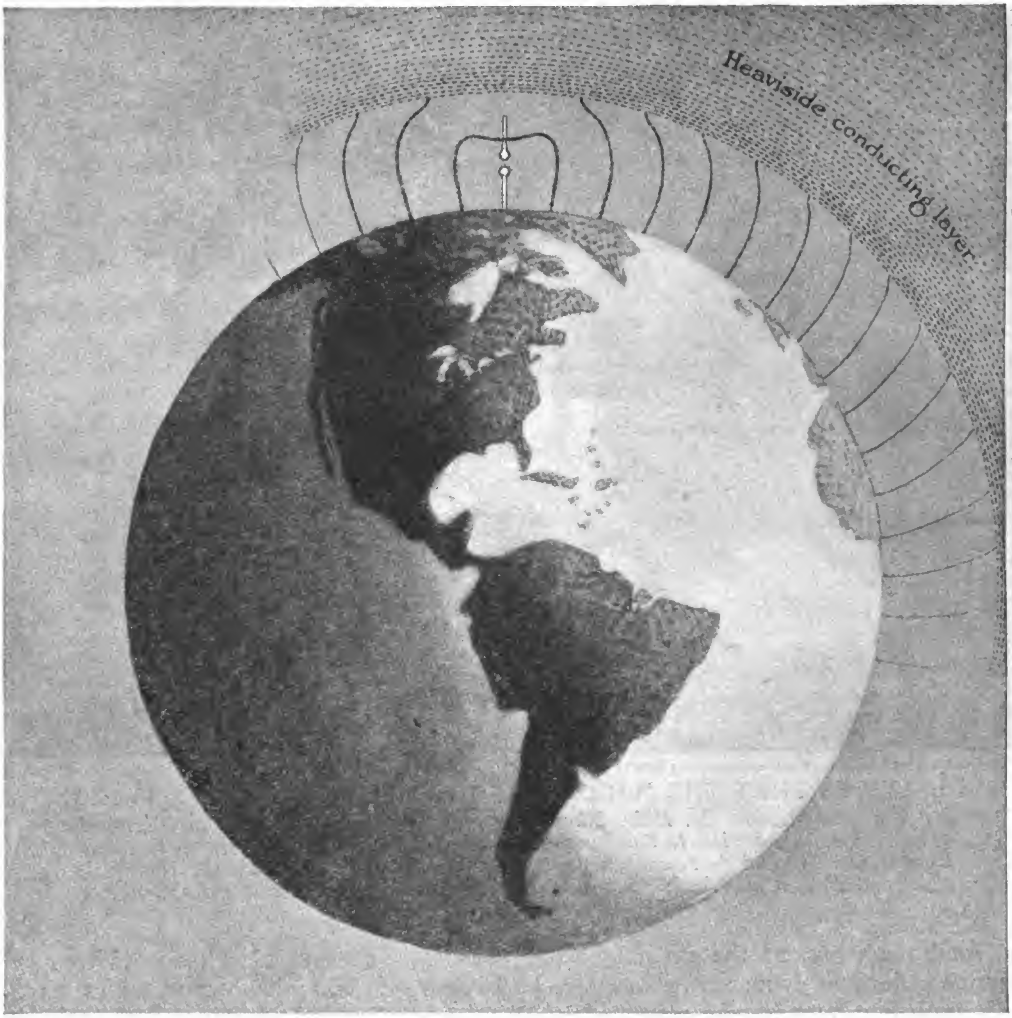


THE "GLIDING WAVE" THEORY—WHICH DR. THOMSON ACCEPTS

"The radio waves are in reality attached to and guided by the earth's surface, and particularly by the sea surface which is more conductive than the land," states the American scientist. According to this theory, the half-Hertzian waves propagated from a grounded system would follow the curvature of the earth and would be accompanied by electric currents in the earth and sea surface, and by magnetic and electrostatic fields in the space above the earth's surface.

It followed that there would be electric currents in the sea and earth-surface accompanying these half-Hertzian waves, and magnetic fields overlying the currents in the space above the earth's surface.

When it was announced by Marconi a few years later that he had received signals across the Atlantic ocean by flying a kite, the cord of which constituted an antenna with the usual ground, many regarded him as something of a faker. At least, they believed that he was mistaken in his observations. Among these doubters were not a few of the leading scientific men and engineers of the day. It followed that if the waves were of true Hertzian type and were propagated in straight lines, they could not by any possibility curve around and over a mountain of water nearly two hundred miles high, as they would have had to do if they



THE "HEAVISIDE LAYER" THEORY—WHICH SIR OLIVER LODGE DEFENDS

The "conducting layer" theory, which is proving a bone of contention among scientists, assumes that this hypothetical Heaviside layer (which would have to present a smooth surface fairly impenetrable to the radio waves) bends these radio waves by successive reflections, without diffusing or mixing them up, around the surface of the earth. "This assumption," according to Dr. Elihu Thomson, "strains the imagination too far, and plainly will not work."

crossed the Atlantic close enough to the earth's surface to be detected.

As it was soon demonstrated that Marconi was right and that the signals *did* come around the curve of the earth's surface, those scientists who failed to recognize (and some of them even yet seem so to fail) that there was a fundamental difference between the waves in their propagation and in their generation as regards true Hertzian waves, had been mistaken—and not Marconi.

Then a singular thing happened.

When confronted with the facts, this assumption pure and simple was made, which unfortunately lives and has character even today: that there was an electric mirror of ionized gas, or conducting gas, say fifty or sixty miles up in our atmosphere, the under surface of which was so definite as to reflect the waves without diffusing or mixing them up, and

From a photograph made for POPULAR RADIO by General Electric

HE BELIEVES THAT THE "CONDUCTING LAYER" THEORY IS A FALLACY

No one can question Dr. Elihu Thomson's standing as an authority on electrical phenomena. In addition to degrees from several universities, membership in many learned societies and decorations from foreign governments, he holds the Rumford, Fritz and Edison medals in science. He is the head of the Thomson Laboratories of the General Electric Company.

so send them around the earth by successive reflections from above.

I think that anyone who reflects for a moment on the requirements in such a case must predict that such an assumption is not only unnecessary, but that it strains the imagination too far, and plainly will not work. In order to work, it would have to be something like a metal surface, confined to a certain smooth regularity and of such a nature that the wave fronts could not penetrate it to any considerable depth without being turned back. It must be without swellings or wavy contour, and it must reflect the waves in such a way as not to interfere with those that are more directly transmitted, and so keep the waves in phase. It would have to be, as it were, Nature's gigantic whispering gallery for electric waves. The assumption itself (if it could be shown to be probably true, with the required limitations) might have justified the extended and complicated mathematical treatment it has received at the hands of some able men. But an assumption, if not needed or not true, is not helped by such treatment. The mathematics may be valid enough, but they do not make the assumption itself valid. Reasoning on false premises, whether mathematically or otherwise, does not make the conclusions valid.

According to what has for many years been known as the "gliding wave" theory, there never was and never could have been any doubt of the waves used by Marconi (the half-Hertzian) following the rotundity of the earth's surface.

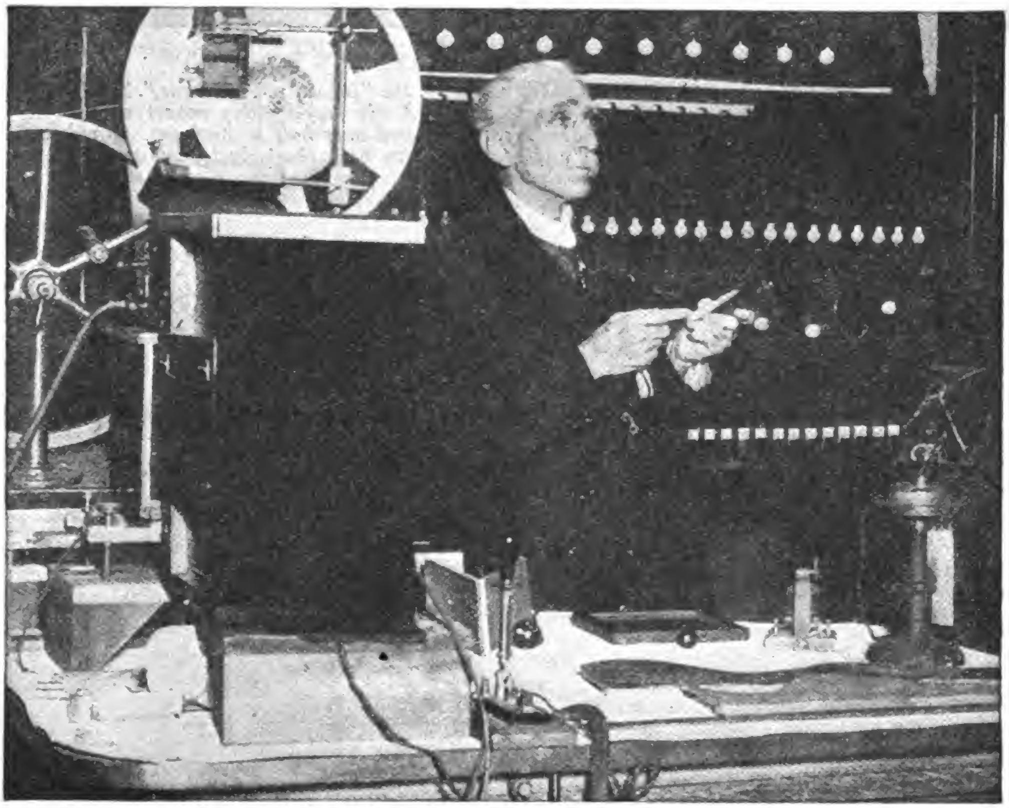
Experience shows that transmission over the sea is far better than over the land. Direction finding discloses that the direction of transmission favors the sea.

Experience shows that when the land surface between two stations has been wetted by rains, great improvement in the transmission follows, to be again lost when the land surface is once more dried by evaporation. A good ground for the transmitting system or an ample condenser counterpoise is shown to favor greatly the launching of the waves. That the waves above the earth's surface tend to follow closely that surface, or may even be said to cling thereto, accords with the results obtained from ærial antennæ, ground antennæ and loops or coils used as antennæ.

There never has been any occasion for the existence of the assumption of an upper conducting layer of such a nature as to reflect the waves without confusing them or diffusing them, and it is regrettable that such an assumption, having once received the sanction of great names, thereby continues to have a support and recognition which should never have been given and was never needed.

The views presented by me in 1913* have been more and more confirmed by practice in the years since elapsed. They represented the views of the group, by whom the assumption of an upper reflecting layer was recognized from the start as a fallacy.

**See "Wireless Transmission of Energy," published in the Report of the Smithsonian Institution for the year 1913, pages 243 to 260, inclusive.*



Kadel & Herbert

ONE OF THE EARLIEST BELIEVERS IN THE HEAVISIDE THEORY

An apostle of the Heaviside theory, Dr. J. A. Fleming, F.R.S., a scientist and physicist of the highest type who has contributed many valuable books on scientific subjects and has made exhaustive researches in radio and the characteristics of dielectrics. He is the inventor of the Fleming valve, the first vacuum tube used in radio.

Kadel & Herbert

4,000,000 BASEBALL FANS HEARD HIS VOICE

When Grantland Rice, the popular sport editor of the "New York Tribune," broadcast from the New York Polo Grounds via WJZ his play-by-play report of the world-series baseball games, his audience was scattered over half a continent. Grand opera, symphony concerts, lectures and speeches have been similarly transmitted by wire to broadcast stations. The immediate problem before the broadcasting stations today is to obtain the wire service.

WHO WILL PAY FOR

BROADCASTING?

A Frank and Searching Outline of Radio's Most Pressing Problem and the Possible Ways of Solving It

By WALDEMAR KAEMPFFERT

The Broadcasting Crisis in a Nutshell:

UPON the nature of the broadcast programs the public interest in radio—and consequently the immediate future of the radio industry—is hanging.

When radio first seized upon the public fancy, interest was centered on the radio apparatus itself—the mechanical medium by which the broadcast programs were received. The novelty of the instrument must inevitably pass. The public's interest is properly becoming centered on the programs themselves.

Radio is unquestionably destined to play a vital part in the affairs of men, perhaps a more vital part than has ever been played by a single invention or discovery. It is vastly more than a mere instrument for receiving jazz, bed-time stories and similar light entertainment. It has already demonstrated its significance as a great educational and cultural force. The foremost educators and publicists of the country are beginning to realize its possibilities. Radio is beginning to take its place as an instrument for rendering a world-wide public service of inestimable value.

The day when eminent musicians, lecturers and others can be induced to visit remote broadcasting stations and entertain free of charge is passing.

To meet this situation POPULAR RADIO has proposed a nation-wide broadcasting project that offers a practical solution that *can be put*

into immediate effect. It aims to raise the broadcast programs to the highest possible level, to the end that they may be coordinated and made to serve a great public service.

Briefly, the plan provides:

1. For the installation of permanent wiring to the more important auditoriums where musical programs, lectures by eminent scientists and publicists, and other important features are given.

2. For the transmission by wire, to a small but highly select group of powerful and adequately equipped radio stations, such programs as may be selected for broadcasting.

3. For the coordination of these important features as elements of an organized program, developed on a nation-wide scale, under the direction of properly constituted authorities that may include the country's foremost educators, scientists and patrons of the fine arts.

In other words, the plan provides for reaching out and tapping those auditoriums, lecture-rooms, opera houses, concert halls, athletic fields—possibly even the halls of Congress—to the end that the world's greatest music and the world's greatest scientists and publicists may be figuratively brought into the home of every radio fan—and eventually into every school and college.

That the project is eminently practical from a technical standpoint has been repeatedly demonstrated, notably by the broadcasting of the Philharmonic Orchestra concerts from the City College Stadium in New York last summer—an enterprise initiated by this magazine.

The project has been outlined to some of the leading educators, scientists and patrons of the fine arts in the country, who are not merely giving it their endorsement but in many cases are giving it their active cooperation.

To carry this project (or any similar project) into effect requires wires. Without wires the programs cannot be conveyed to the broadcasting stations.

The immediate problem is: How may the necessary wires be obtained?—EDITOR

DR. FOSTER of Newark felt constrained to open a broadcast sermon with the words: "I cannot address you as citizens of Newark because my voice is being heard beyond the limits of the city. I cannot address you as fellow Americans because my voice is being heard perhaps in Cuba, in Canada, and in Central America. I cannot address you as brethren of my faith, because only a very insignificant part of the great number who are listening to me are of my own faith. And, therefore, I must address you as fellow human beings."

Here we catch a glimpse of the social destiny that radio will fulfil. The United States shrinks into a pocket handkerchief, the world into a little ball that can be held in the hand. We boast of the magnificent distances that make these United States what they are; yet, because they are magnificent, these distances estrange us. To most of us Oakland, Seattle, St. Louis are mere places on the map. An idea holds us together—the idea that we of St. Louis, Chicago, and New York are all citizens of the same commonwealth. Radio will achieve the task of giving a reality to this idea.

Henceforth the actual voices of Presi-

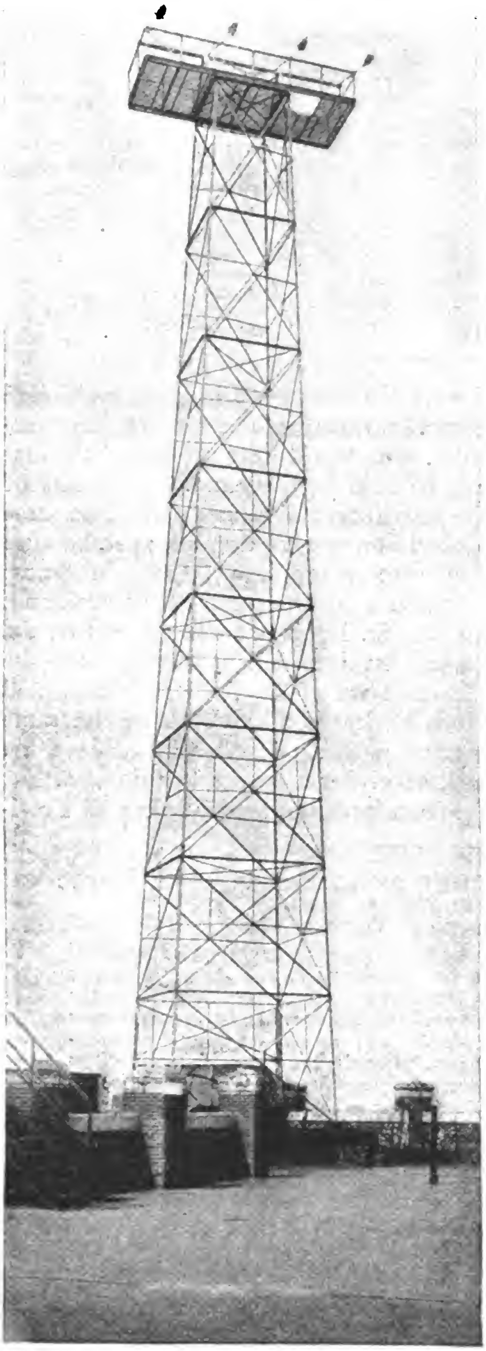
Brown Bros.

Broadcasting as an Educational Force

TO THE EDITOR OF POPULAR RADIO:

"I fully appreciate the very great educational possibilities of broadcasting, and let me also say that I am in every way sympathetic with the movement which will bring to the great masses of the people the opportunity to hear by broadcasting the exceptional concerts which are given by such organizations as the Philharmonic, as well as to hear our great singers and lecturers."

President, the New York Philharmonic Society



dents and Governors will be heard by the people. No longer will we be content with the cold, impersonal type by which official proclamations and messages now reach us. The President of the United States will be a real personality—something more than an abstraction. He will literally enter every home when the occasion justifies his addressing the people of the United States in person. Solemn as was Woodrow Wilson's declaration of war on the memorable day when he called upon Congress to break with Germany, a thousand times more solemn would have been the accents of his living voice than were the scareheads by which his declaration was announced by the newspapers.

The phonograph has brought the interpretations of great musicians into the homes of lonely farmers and ranchmen. But radio will carry to the great open spaces the plays, the lectures, the operas that make city life what it is. It will link Fifth Avenue millionaires with Wyoming cow-punchers, sailors on lonely seas with Massachusetts mechanics. The lumberman of the north woods, the sugar-planter of the south, the California fruit grower and the Virginia tobacco planter will become next door neighbors of the ether. Radio is destined to transform the United States, the whole continent, into a huge auditorium.

¶ ***But before anything remotely resembling this radio millennium can come to pass, broadcasting must be organized as a business.***

Present-day broadcasting is an astounding anomaly. Probably the manufacturers of radio sets who first timidly began to entertain the multitude and who were amazed at the overwhelming, enthusiastic response of that same multitude never realized that, like nobility, broadcasting imposes obligations.

THE MOST SIGNIFICANT STATION IN AMERICA?

Despite the fact that WBAY has met with unexpected technical difficulties and is still inoperative pending "experimental work," it may yet prove to be the storm center—or the solution—of the whole broadcasting problem.

Like the lawyers when they cross-examine an expert, let us ask a hypothetical question or two.

Assuming that within the range of WPQ, the manufacturer who pays the expense of maintaining the station has sold all the sets that the territory will absorb, will he continue to pay from $2,000 to $10,000 a month to instruct and amuse his one-time customers, as well as the customers of his competitors?

Or, will he pocket his profits and stop broadcasting then and there?

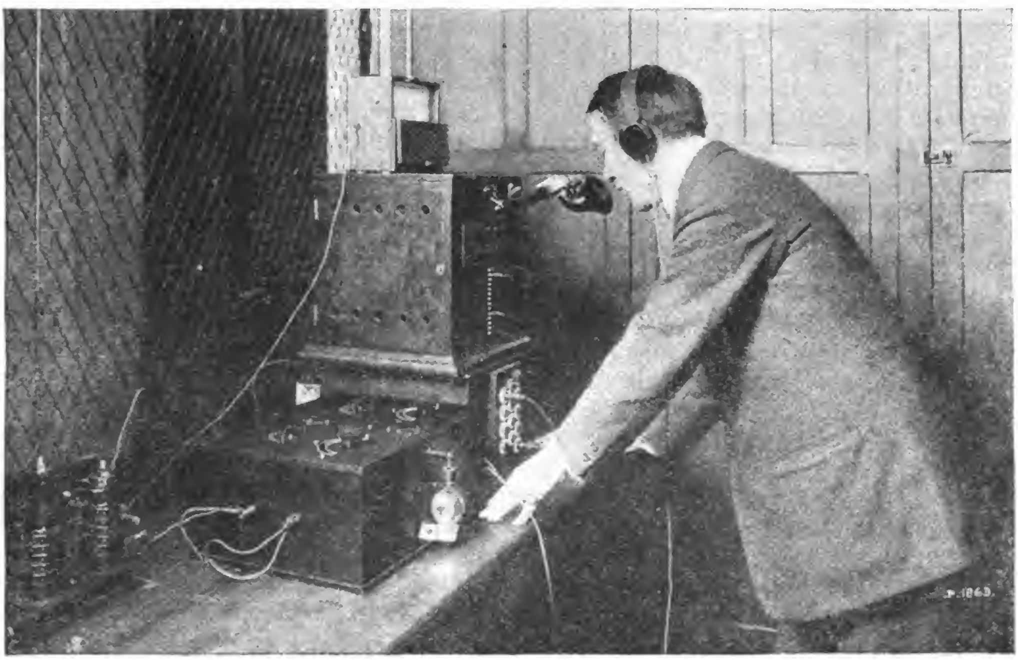
We have but to ask these questions to expose the inmost nature of the broadcasting station's true function. *Broadcasting is essentially a public utility.*

The department stores and newspapers may have the right to close their stations, but the manufacturer of radio sets who has taken it upon himself to radiate music and lectures into space, primarily in the interest of those who have purchased his apparatus—dare he stop? Will he be permitted to stop? Is not his reputation for honest dealing at stake?

Clearly, there is a radio burden as well as a White Man's burden.

The time is rapidly approaching when the novelty of singing for nothing into a transmitter will wear off, when artists, actors, and professional lecturers will ask: "What is there in it for me?"

Professional entertainers do not live by publicity alone. Broadcasting is bound to become more and more expensive as the public demand for better and better programs becomes more and more insistent. The electric light company that supplies current, the city street railway system that provides cheap transportation, the water company upon which thousands are dependent, the public utility company that renders any service whatever cannot afford to ignore the rights of those that it undertakes to serve. And broadcasting is already a public utility. Some way must be found of making it profitable.



RADIO SERVICE TO MOVING TRAINS

As long ago as 1915 the Lackawanna Railroad experimented successfully with radio communication between its headquarters and its trains en route. Last August the concerts of the New York Philharmonic Orchestra were heard on Lackawanna trains in Pennsylvania.

Someone has cried: "Let the Government levy a tax on radio receivers and contribute the proceeds to the support of broadcasting stations."

In Europe, familiar as it is with operas and theaters supported by the state and the city, it is conceivable that money might thus be raised. But a radio subsidy in America—never. We haven't even a national theater or a national opera.

Radio blazed into being, so far as the general public is concerned, simply because the broadcasting station flashed song and speech into space. Broadcasting stations must be maintained, and expensively maintained, if this marvelous interest is not to languish and die overnight. And that it will be maintained there can be no doubt. To keep the public interest alive some means must be devised of collecting revenue from the public. But how?

The Radio Apparatus Section of the Associated Manufacturers of Electrical Supplies, comprising at present about twenty of the more enlightened and progressive makers of radio apparatus, has expressed its willingness to share the financial burden imposed by broadcasting. The business of broadcasting is to become co-operative, and the self-imposed taxes will, of course, be passed on to the public after the manner of all taxes. Upon the apparatus of the contributing manufacturers the insignia of the Association is to be placed—a symbol signifying that they have recognized their obligation and have met it by the payment of a fair levy. No doubt a few "get-rich-quick" manufacturers will refuse to pay the slight, just tribute demanded, but the conspicuous absence of the Association's insignia from their sets will proclaim these Wallingfords of the industry for what they are. Whether or not the public will be moved by its sense of fair play to refrain from buying instruments that are not thus identified by the Association's seal, remains to be seen.

If co-operative broadcasting is thus undertaken by most of the manufacturers, one station will take the place of many stations. The interference that now marks attempts to receive on wavelengths that differ from one another by only a few meters will disappear. Moreover, not one company but many companies will dictate the character of programs, and broadcasting will more accurately reflect the public taste.

One unique plan is that devised by the American Telegraph and Telephone Company as the result of an "insistent demand" for broadcasting facilities. The company's manufacturing subsidiary received numerous orders for private broadcasting instruments, which, had they been made and sold, would have increased the difficulty now experienced in avoiding interference. Moreover, there were many small firms that could not afford to install their own transmitting stations and that wanted to make the most of radio's possibilities. *Broadcast for hire* was the solution. So, the American Telegraph and Telephone Company has built an experimental station (WBAY, located in New York City), which may be rented for a definite time at a fixed price by anyone who has a message to convey or a song to sing.

Assume that you are a manufacturer of pianos. You wish to impress a vast radio audience with the tone quality of your instrument. You hire the station for an hour a day, three days in the week, for two months. The announcer introduces himself and his subject, "Signor Pablo Portadino, the well-known baritone of the Metropolitan Opera House, will sing the Prologue from *I Pagliacci*, accompanied by Giuseppe Martucci on the Benson concert-grand piano." Giuseppe strikes the opening chords and Portadino proceeds to explain in rich Italian tones that the players on the stage are only human. The tone quality of the piano must make some impression.

Or, you are a manufacturer of vacuum cleaners and you wish to instill in your

Photo by Post-Dispatch, St. Louis

A PILLAR ON WHICH THE RADIO INDUSTRY RESTS

Such broadcasting stations as this one (KSD in St. Louis) keep alive the public's interest in radio. It may soon become part of a great radio net for relaying the world's best music and the voices of the world's foremost scientists, educators and publicists into every home and school, as part of a nation-wide educational program.

unnumbered audience a holy fear of dust. You describe alarmingly what work a broom does in casting up disease germs. Then you contrast these unhygienic, preposterous proceedings with the modern sanitary method of vacuum-cleaning. "To anyone who brings us orders for five Supreme vacuum cleaners," your hired tempter concludes, 'the Supreme Vacuum Cleaner Company will give a crystal-detector radio set."

Or, you are running for Mayor of New York and you are opposed by too many influential newspapers. To reach the voters you plead with them for half an hour each night over a period of two weeks preceding election.

The plan has possibilities. To be sure, the advertiser, the political candidate, the social reformer, the religious fanatic will be the first to avail himself of the golden radio opportunity presented. How will

the public respond? It is impossible to foretell. If the lecture is dull, if the musical bait offered by the piano manufacturer is not appetizing enough to be swallowed, it is assumed that the radio audience will voice its disapproval by letter to the firm or orator responsible for a dull radio time.

In the evening, the station will broadcast sheer entertainment—music, talks on interesting subjects, stories. The morning and other hours of the day will be reserved for the advertiser and the propagandist. No matter what price he may be willing to pay he must not trespass on the evening, unless he is ingenious enough to devise a feature that will harmonize with a concert program. When the government finally allocates wavelengths the station will modify this policy. Instead of limiting the advertiser and the man with an axe to grind to a specific time of day, the station will assign him to a wavelength on which he may expound to his heart's content at any hour that happens to be available.

The government has already indicated that it will not permit a wholesale abuse of radio by the advertiser.

On the other hand, advertising on some wavelengths will be permitted. If advertising proves to be the American Telegraph and Telephone Company's chief source of revenue, it will have to be of a new, almost hypnotic variety. It must hold the interest as if it were a play or a comic opera. Lecturers must be found as winning and convincing as the serpent in the garden of Eden. If the hired stentor contents himself with: "Ladies and Gentlemen, the Morpheus mattress, which is made by the well-known Rosenberg Company of Kalamazoo, has the softness of a downy cloud and the durability of battleship armor," his audience will yawn and glide to a wavelength on which Al Jolson is singing "April Showers," or a popular jazz orchestra is playing the latest fox trot.

But the American Telegraph and Telephone Company is not concerned with these aspects of radio propaganda. Its sole business is to operate a station for hire; it leaves possible patrons to their own devices. It will certainly be cheaper for newspapers and department stores to hire such a public service station by the hour than to conduct stations of their own. From these sources alone revenue enough may be earned to pay all broadcasting costs.

But what of opera, what of artistic song recitals, what of lectures by distinguished university professors—lectures purely educational in character?

The company will do much to use radio for this purpose at first during the evening hours and later on special wavelengths. Perhaps a Carnegie, ashamed to die rich, will hire the WBAY station and pay theatrical managers for the privilege of brightening thousands of homes. It is music and lectures, sent through space, without thought of any direct personal advantage to the broadcaster, that have made radio what it has become. If the American Telegraph and Telephone Company has actually conceived the most practical plan of placing radio broadcasting on a sound business footing, possibly municipalities may pay the royalty that will unquestionably be demanded by the producers of operas and plays. And why not? Every self-respecting community now taxes itself for parks and the bands that play in them.

If the American Telegraph and Telephone Company's experiment proves successful we shall undoubtedly witness the establishment of broadcasting stations that can be hired by the hour, day or week, all over the country—stations interconnected by special wires so that the radio address delivered in New York may be simultaneously broadcasted from Maine to California. Other engaging possibilities suggest themselves. A public utility broadcasting service, such as this, nation-wide in its scope, may well claim from the Government the right to radiate on a dozen different wavelengths, so that

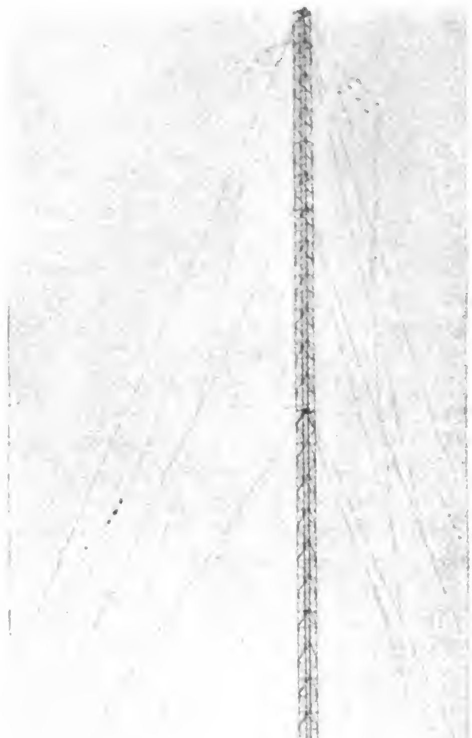
concerts may reach us on one, the news of the day on another, educational discourses on a third, artful propaganda on a fourth.

Certainly one broadcasting station, subject only to such control as the Government may impose, is more likely to serve the public better than a number of stations in the same community. Indeed, as time passes and radio develops, a few broadcasting stations, erected at strategic points, will probably take the place of hundreds that are bound to be established within the next year or two. There will be less interference, and the tuning will be sharper and more selective.

Broadcasting stations are now far too eclectic. They give us weather reports, stock market quotations, orchestral music, bedtime stories for children, lectures, and Arlington time. The Government regulations, being what they are, we must accept what reaches us on the prescribed wavelength whether we like it or not. There is little opportunity of "tuning in" to receive what another station has to offer, if the closing prices on the stock exchange do not interest us, simply because near-by stations all transmit on the same wavelength and must so time their programs that there will be no interference. Mr. Hoover's commission has allocated wavelengths, and if its

WHO PAYS FOR SUCH STATIONS, AND WHY?

Properly enough, Boston's foremost broadcasting station, WGI, is located within the grounds of Tufts College. Who will eventually pay for maintaining broadcast programs?



Westinghouse

WILL RADIO PUT THE SMALL CHURCH INTO THE DISCARD?

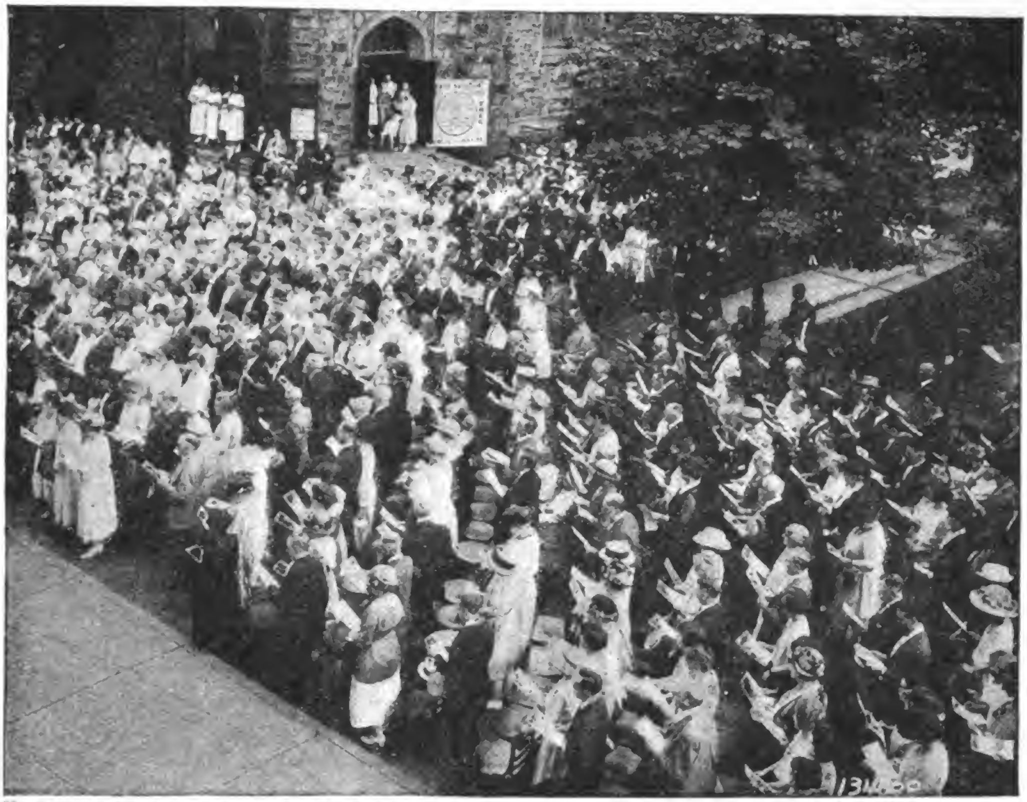
This particular community service in Pennsylvania was broadcast from KDKA. Services in the country's foremost churches may be similarly broadcast—with the aid of wires to the radio stations.

recommendations become Governmental regulations, radio entertainment and instruction will reduce itself to a matter of wavelengths rather than of stations. In other words, sporting news, symphonic music, song and instrumental recitals, dance music, stories, and lectures will each be radiated on its own wavelength.

Hence, the receiving set of the future may possibly be provided with tuning dials bearing such legends as "Jazz," "Opera," "News," "Market Reports," "Musical Comedy," and "Symphony Orchestra." We shall turn the dials of our sets to the proper legend and listen to that which happens to interest us most at the moment.

Whatever may be thought of the practicability of the significant experiment of the American Telegraph and Telephone Company, the ultimate possible linking of our wire-telephone system with a score of broadcasting stations that can be hired, as one hires a taxicab, reveals the true relation of radio to the wire system of communication, although the company intends to connect stations by special wires. Only a fantastically optimistic radio enthusiast cherishes the illusion that radio will completely supplant wires—that all the miles of wire, all the complex, ingenious switchboards in central stations, all the expensive conduits that encase cables will be scrapped. The truth is that radio will prove to be a valuable extension of the network of wires that enmeshes the country and the continent. In the future drama, music, entertainment will be picked up wherever it is available at its best and carried by wire directly to the broadcasting station.

"We shall have the pleasure of listening to Madame Rubin, late of the Warsaw Opera, in a rendition of the Mad Scene from *La Gioconda,"* announces the voice at the broadcasting station. In these paleozoic days of radio, Madame has obligingly motored, trolleyed, or otherwise transported herself to the broadcasting station, there to plant herself in front of the transmitter and give her full-throated best. In the near future, Madame will exercise her prima donna's right of displaying her temperament and of singing, when, where and how she pleases. Instead of transporting her heaving bosom to the broadcasting station, she will sit at home, sing into a transmitter, and her voice will be carried by wire to the broadcasting transmitter by which it will be prodigally radiated into space. At present, the sheer novelty of singing from a broadcasting station, of momentarily converting herself into a vocal sun that shines into thousands of homes is enough to induce her to present herself in person at the station. If



Westinghouse

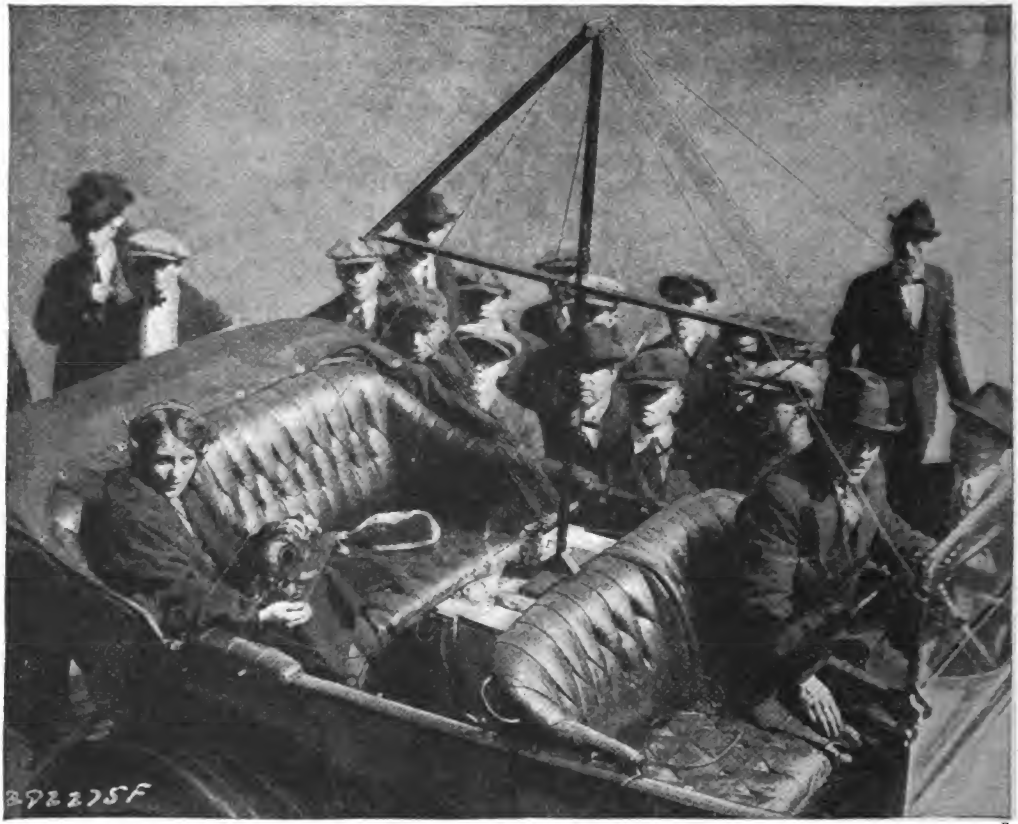
Madame only knew that even now she might sing to millions in her boudoir, clad in a comfortable kimono!

"Listeners-in" there will always be in the great cities, but it is in enlivening the dull small town and the lonely farmhouse, in robbing the great open spaces of their loneliness and monotony, that radio will probably play its most important part. Hence, we may find broadcasting stations serving both the country and the city by radio and telephone.

The use of city telephone wires to bring to apartment-house dwellers the strains sung into the transmitter of a distant broad-casting station suggests an extension by the carrier-wave system of what may be called "narrow-casting." The system has been so frequently discussed, particularly in the pages of this magazine, that the principle upon which its operation is based need not be elaborated here. It is enough to recall that high-frequency currents can be transmitted over telephone or power line without interfering with one another or with the currents for conducting which the lines are built. There would be no difficulty about collecting revenue. The telephone company would rent an extra telephone receiver, even a loud-speaker, to each subscriber. "Plug in" and you hear the music transmitted from the central station.

Similarly, the electric light companies could narrowcast over their own lines. They have but to install the necessary high-frequency transmitting apparatus and to supply proper receiving instruments.

When telephone or power lines are thus used for wire narrowcasting there will be none of the interference that now marks radio broadcasting. Gone will be the dots and dashes of the telegraphic spark-set, and gone the grinding of static. Gone, too, will be the possibility of getting something for nothing by "listening in" with a home-made receiver.



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PRACTICAL—BUT INCONVENIENT

If this motorist really wants to receive broadcast programs, this installation may be commended on grounds of efficiency. But it is a bit spectacular for the average fan.

Radio on Your Motor Car

Eight Ideas for Installing a Receiving Set That Will Really Work

By FREDERICK SIEMENS

TO install a radio receiving set on your automobile is a thoroughly practical undertaking—provided, of course, that you observe the approved scientific methods of installation and disregard the fantastic conceptions of inexperienced novices or publicity seekers, who rig up "stunt" sets that are designed rather to attract attention than to receive radio signals. There are few outdoor uses of radio that have excited more popular interest than its application to the pleasure car; yet the number of fake installations that do not work has tended to discredit such attempts on the part of the amateur.

There is no reason, however, why such installations should not be widely popular; indeed, the rapidly growing number of them would indicate that they are opening up new possibilities for enjoyment, particularly during the fall and spring months when the weather conditions are propitious for outdoor sports and when the static is not a serious

factor In some cases the success of such radio-equipped motor cars has been so marked that sets supplemented by loudspeakers have blocked the traffic and called for police interference.

The most important point to be considered in such an installation is the type of energy collector or antenna which is to be used.

First of all there is the vertical loop antenna. This type of antenna gives good results; but to attain the maximum efficiency it must be pointed directly at the transmitting station, and this is not always possible on account of the ungainliness of the apparatus. Who, for example, would care to have a loop such as is shown at the head of this article, permanently installed on his car?

Of course, a miniature vertical loop can be installed somewhere out of the way on the car, as is shown in one of the other pictures, but even in such a case the whole car must be pointed at the transmitting station in order to get loudest results.

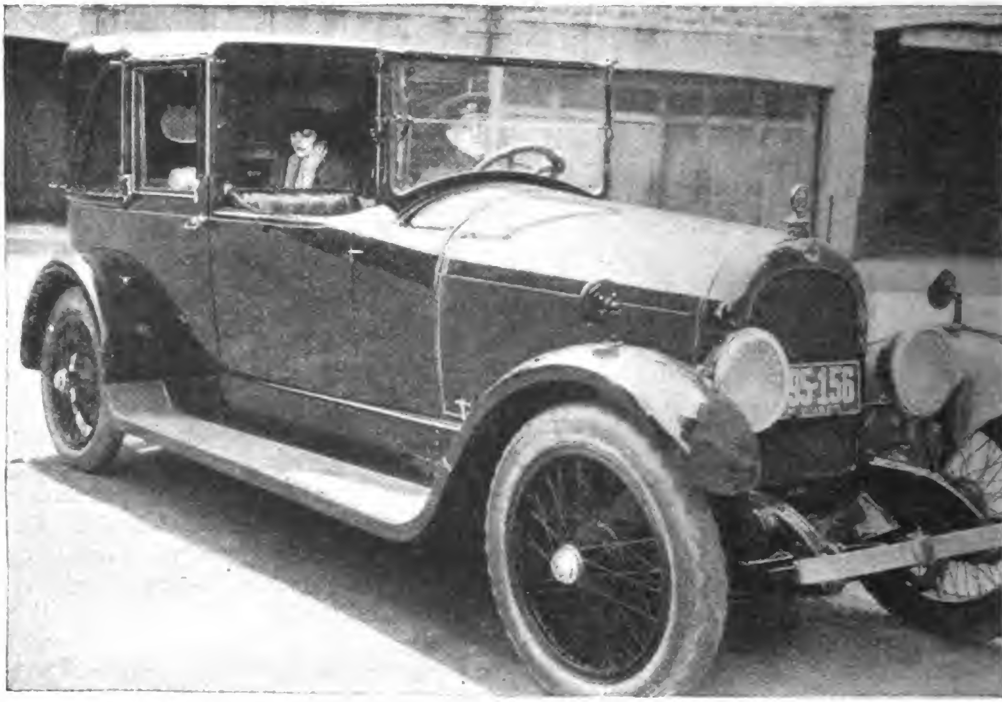
One interesting application of the loop type of antenna to automobile uses is that used by E. B. Myers in the set he designed for Miss Corinne Griffith, the film actress. This apparatus is in effect a portable radio set with radio frequency amplifiers and a vertical loop antenna fashioned into the cover of the valise-like carrier. When the set is in use the lid is opened and the whole set is turned until the received signals are heard most clearly. This set can be placed on the seat of any motor car, as it takes up scarcely any more room than a person, even with its equipment of batteries. With such an outfit it is reported that broadcasting programs can be heard a distance of fifty miles or more. Six tubes are used for this purpose, including three stages of radio and two stages of audio frequency amplification, and a detector.

Another form of loop antenna which can be used successfully is known as the "horizontal loop." This type of antenna is particularly adaptable to installation

From a photograph made for POPULAR RADIO

THE ARMSTRONG SUPER-REGENERATIVE SET ON AN AUTOMOBILE

The vertical loop, located at the rear of the car, in combination with a loudspeaker, creates such a volume of sound that the owner was warned by a traffic policeman in New York against collecting a crowd that obstructed traffic.



A PORTABLE SET DE LUXE

The loop antenna, the property of Miss Corinne Griffith, the film star, is coiled in the leather case of the portable receiving set, which may be carried about and used with no more inconvenience than a traveling bag.

International

THIS ANTENNA IS DRAPED OVER THE TOP OF THE CAR

A Chicago physician, Dr. David Cottrell, uses the radiator cap as one support of his antenna and the rear tire rack for the other.

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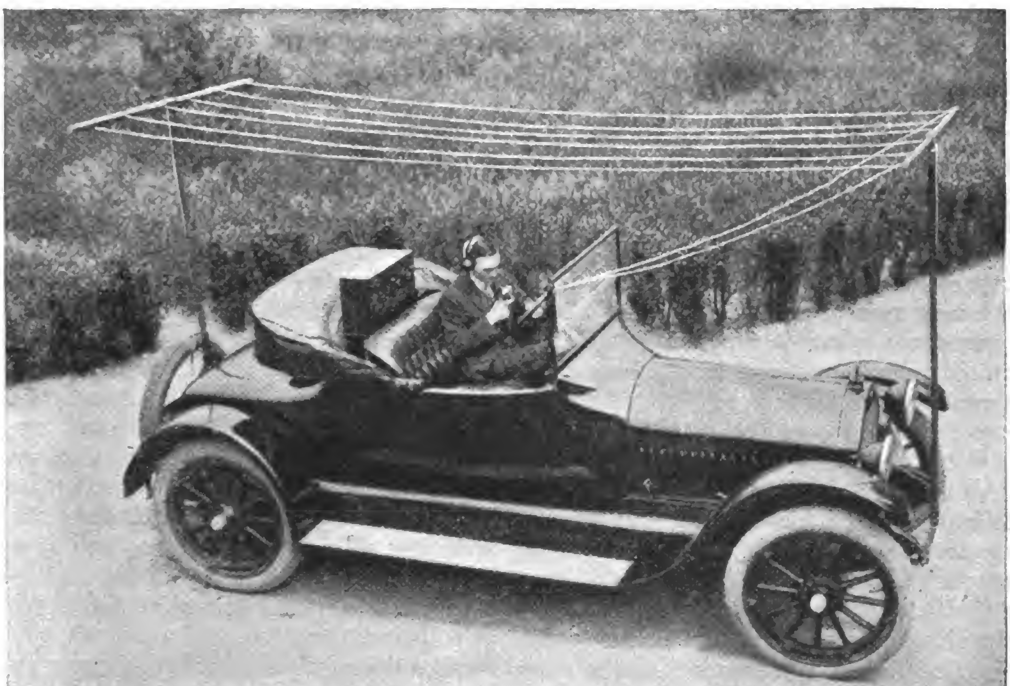
A HORIZONTAL LOOP ANTENNA ON THE ROOF OF A LIMOUSINE

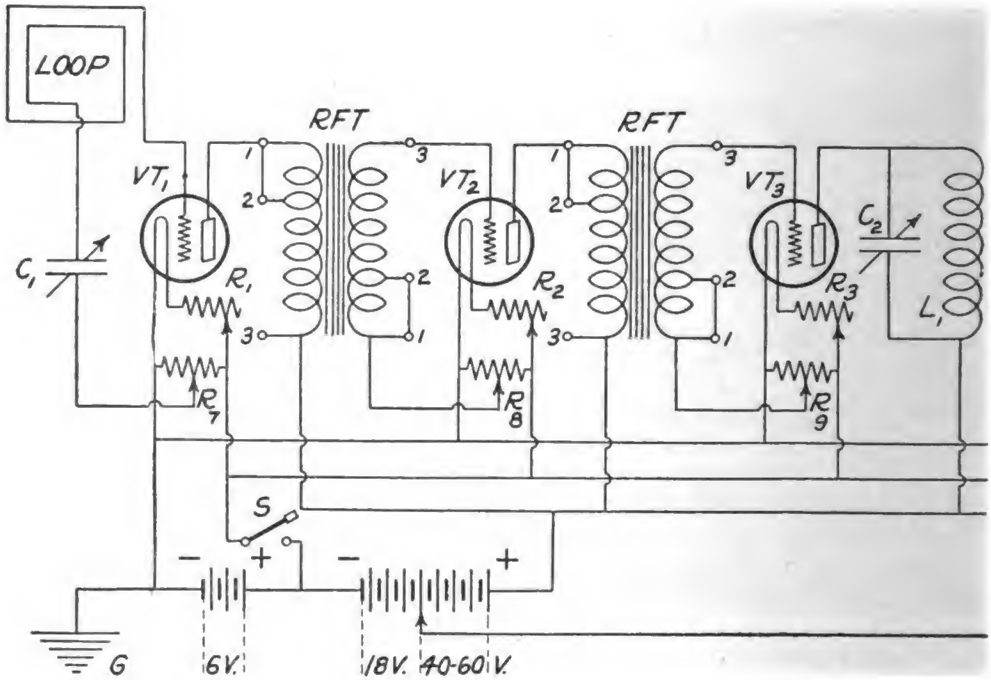
This installation may be made a permanent fixture on the car, and has the advantage of being out of the way. This set, owned by a Cincinnati fan, cost $50.



Pacific and Atlantic

CUMBERSOME—BUT ESSENTIALLY PRACTICAL

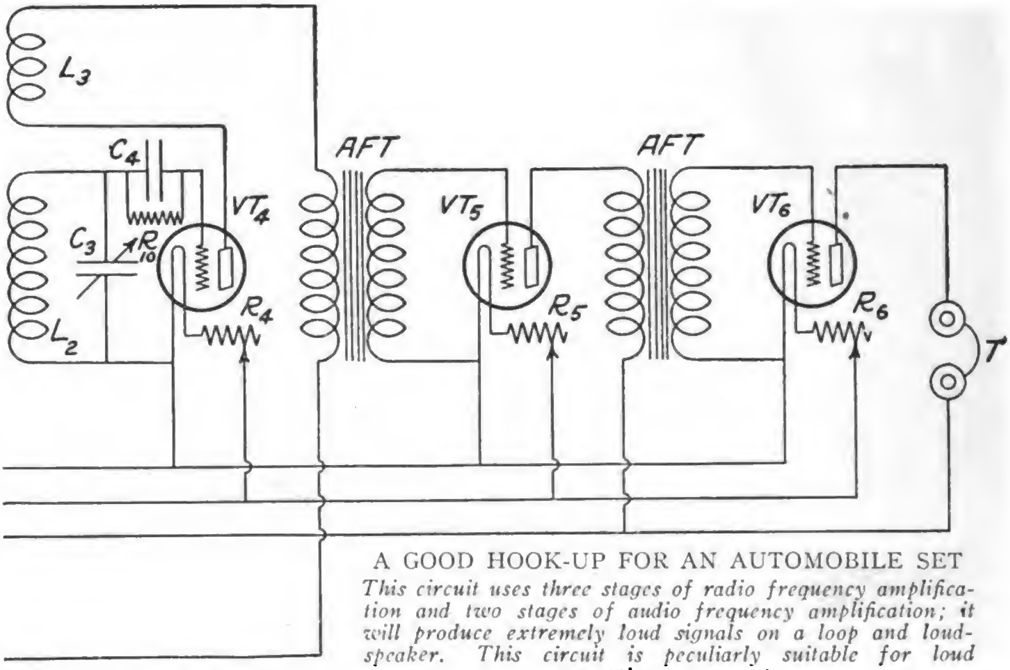
Here is a real antenna, easily dismantled, that A. H. Grebe, of New York, uses both for receiving and transmitting.



on the top of a closed car, such as shown in the illustration on page 249; note that the wires run in a horizontal plane, instead of vertically. This fixed arrangement makes the horizontal form of loop non-directional, or in other words, the antenna receives equally well from any direction. One obvious advantage of this feature is that it does not necessitate turning either the car or the loop for the best results. In order to get loud signals, the same type of receiver with radio frequency amplifiers is necessary as is required with the vertical loop. The horizontal type of antenna might be stitched into the cloth top of the car; in that case it would be invisible and out of the way.

A third type of antenna which seems to be the most popular of all with which amateurs experiment is the small flat-top antenna supported on short masts fore and aft. Such an outfit is illustrated in the illustration on page 249. This antenna functions in the same manner as the regular outdoor antenna generally used by amateurs, although on account of its abbreviated size it does not pick up as much energy as its larger cousin. With this antenna system it is necessary to use a ground; the latter is usually made by attaching the wires to the metal chassis of the car. Some of the large busses operated by a transit company in Oakland, California, have had this type of antenna installed; on account of the long bodies of the busses, it was necessary to use only a two-step amplifier set in order to produce good signals. In a short time all of the eighty-five busses of this service will be equipped with radio for the entertainment of the passengers.

A radio equipped motor car that is so elaborate and complete as to come outside of the classification of pleasure car has recently been built by the Chester County Radio Club in Pennsylvania. They purchased a five-ton truck and built upon it a special body in the shape of a regular radio shack, with all the equipment, both for sending and receiving, of a real radio station. Underneath the floor of the shack is fastened a large zinc plate which is used instead of a ground. The plate forms an effective counterpoise. This portable radio station (for it is really that rather than a touring car)



A GOOD HOOK-UP FOR AN AUTOMOBILE SET

This circuit uses three stages of radio frequency amplification and two stages of audio frequency amplification; it will produce extremely loud signals on a loop and loudspeaker. This circuit is peculiarly suitable for loud reception on an auto.

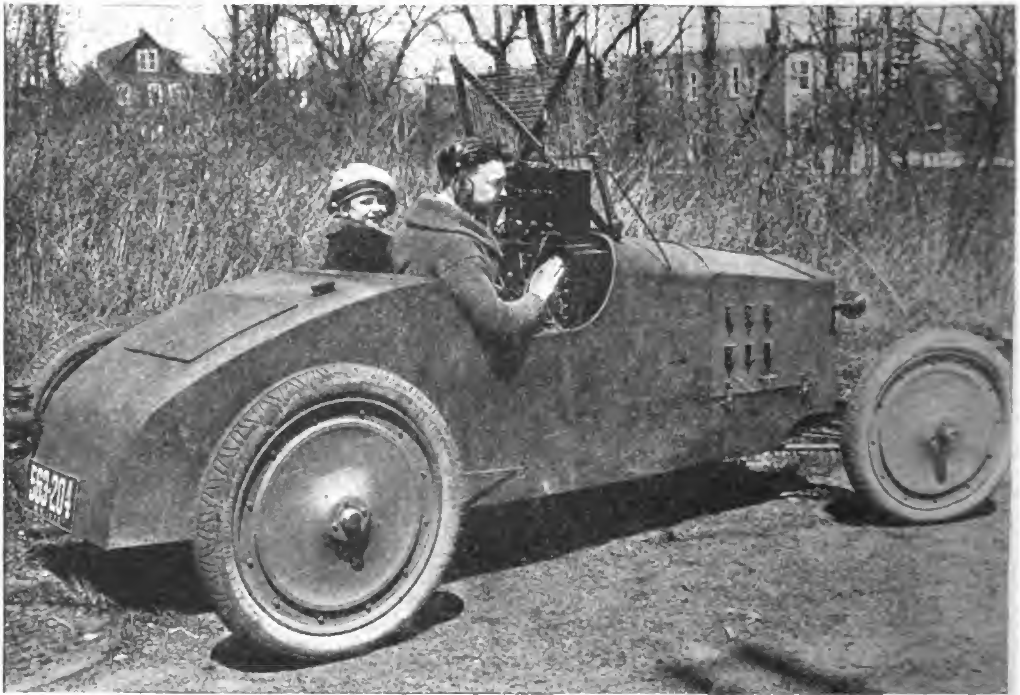
has a government license, and 3OI has been assigned as its official call number. The transmitting equipment consists of a 10-watt radiophone, the receiving set being of the two-step regenerative type. The receiving set of this remarkable machine has copied signals as far away as Indiana, Maine and Georgia.

A Chicago physician has installed a radio receiving set on his car, however, and adopted the same type of antenna. But his antenna is not fastened on masts, running over the top of his coupé instead on special insulating brackets, with the ends fastened on the radiator cap and the tire rack respectively. (See illustration on page 248.) The ground is made on the frame of the car.

One of the first men to do really constructive work in the installation of radio sets on pleasure cars is Al Grebe of Richmond Hill, Long Island. He installed a remarkably efficient antenna of this type, and then proceeded to include on board a transmitting set as well as a receiving set. Both the transmitting and the receiving experiments were very satisfactory. All of the electrical energy for the sets was furnished by the power plant of the car.

A fifth installation which is, in effect, a cross between the last two types of antennæ mentioned, is that employed by M. Phanto. With the use of multi-stage amplification this set can reproduce the broadcasting programs by means of a loudspeaker with such strength that the signals are audible more than a block away from the car. Even racing cars have been equipped with receiving sets to enable the driver to obtain information or instruction while on his dash around the track.

There is no doubt that radio on moving vehicles will be further developed to the point where it will not only be a novelty, but a convenience to the public, as well as a means of direct communication commercially from a company's office to its delivery wagons or trucks. Already radio installations are not unknown on government vehicles; the Army, the fire departments, the forestry service and the police departments are at the present time using radio successfully on their trucks and airplanes. In England the fire



Ewing Galloway

A BIG RECEIVER ON A LITTLE RUNABOUT

This fan, R. E. Leppert, Jr., of Harrison, New York, has shown ingenuity not only in installing a practical set on his car, but also in camouflaging his Ford!

departments of some of the cities have been carrying on experiments to determine the value and usefulness of radio communication. Radio telephone transmitters and receivers have been installed on the trucks of a number of its fire brigades, and have proved effective in keeping the home station and the trucks in touch with each other in a way that has been impossible heretofore. The antenna system employed on the cars consists of a wire strung from a pole at the rear of the truck to any support that happens to be in the vicinity. Grounding of the apparatus is accomplished by means of throwing out two large wire-mesh mats which are attached to the set by means of insulated wires. Of course this system can be used only when the truck is motionless, but the increased length of the antenna adds so greatly to the range of the set that this disadvantage is said to be more than offset. The use of radio on commercial trucks is anticipated by a large baking company in Philadelphia, which has installed sets on its delivery trucks; among the purposes one is to direct the out-of-town delivery service.

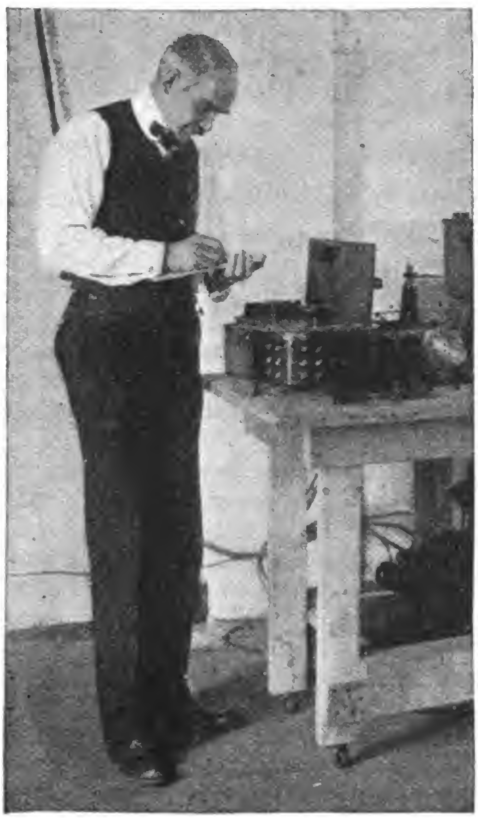
The police are also using radio motor vans to deal with emergencies that arise in the handling of crowds during public demonstrations.

The motorized radio played quite a part in successfully dealing with the massed crowds during the last May Day demonstrations in Paris. Two large vans equipped with powerful transmitting and sensitive receiving sets were employed for this purpose; one was stationed at Chois Le Rois and the other in the yard of the prefecture, kept there for an emergency call. Both of these vans were in constant communication with each other; and a plane, also equipped with radio, reported any gathering of large crowds to the vans, who in turn issued instructions to the police of that district. The radio in this instance was a powerful

instrument in the hands of the law, as it kept all districts under supervision of the prefecture in a way that would not have been considered possible a few years ago. The type of antenna used was a vertical two-wire affair, supported on a collapsible pole raised through the roof of the van.

Another novel use for radio on a touring car was developed in San Francisco a short time ago by the American Bible Society in "selling Bibles by radio." An auto which was equipped with a radio receiving set carried the voice of A. Wesley Mell, secretary of the Pacific agency, to the crowds that gathered around the car on its passage through the streets.

There is no doubt of the success of motorized radio. The uses to which this form can be put are increasing in number daily. On pleasure cars, however, the most convenient and probably the most efficient type of installation consists of a horizontal loop antenna stitched into the top of the car, with a receiver that uses radio frequency amplification and audio frequency amplification combined. Either the new Armstrong circuit or the circuit shown in Figure 1 would be suitable. The lighting batteries of the car may be used for heating the filaments; the only other batteries required are the "B" batteries. The set can be installed under the dash in front of the seat next to the driver, where it will be out of the way but accessible for adjustment. Such a set would hardly be noticeable in the car; yet its efficiency would enable very loud signals to be received by the use of the loudspeaker.



Paul Thompson

Radio Opens a New Era

To the Editor of Popular Radio:

"It is very gratifying to see someone taking the initiative in a broad-spirited public movement to enlarge the present scope of radio broadcasting. Certainly at the present stage of radio development there is a decided lack of public spirit manifested by those who should be the very ones to take the lead in this matter.

"The possibilities of radio broadcasting, long predicted, are now realized by all who are in any way associated with the engineering side of this new art; all that remains is the application, so that the present generation may enjoy the truly remarkable advantages heretofore retained by the few, but now to be had by the great mass of our population.

"All true lovers of music, all those who desire to extend educational opportunities to the many, government officials who are interested in helping to enrich the lives of many millions—one and all, I believe, owe it not only to themselves but to humanity in general to see that the best in art, education, literature and music is put at the disposal of all those who make up the major part of our nation.

"As one who has long had in view the application of the radio art to the definite field of music, education, art and literature, I am frankly glad to see you enter the lists on behalf of the public."

Lee de Forest

Inventor and Scientist

From a photograph made for POPULAR RADIO

THE AMATEUR WHO DID IT

This is W. K. Thomas. At his right is the transmitter, with the receiver at his left. An ordinary desk telephone microphone is used to talk into, and it is attached to the transmitter, while the telephones on the operator's head are attached to the receiver. The large switch near the operator's hand is used to change from sending to receiving. The completeness of this station typifies the advance of the amateur in radio.

6,000 Miles on 20 Watts

The Remarkable Radio Apparatus Operated by 8LF that Has Made Possible Some of His Notable Achievements

By RICHARD LORD

ON the night of November 6, 1921, radio operator Farmer, on board the steamship *West Prospect,* 2,750 miles west of San Francisco, picked up continuous wave signals from a radio amateur who signed off "8LF." Investigation revealed the amazing fact that in real life 8LF is W. K. Thomas, who lives in Pittsburgh—6,000 miles distant from the remote spot in the Pacific where his signals were recorded on that notable evening.

This achievement is made hardly less remarkable by the knowledge that Mr. Thomas employed a telegraph-telephone transmitter of only 20-watts power. For the benefit of the lay reader, it may be explained that 20 watts represents only about 40 per cent. of the electric power required to operate the ordinary incandescent lamp.

Despite its modest power, however, the Thomas set has proved of remarkable efficiency in long distance transmission. On the night of April 19, 1921, it carried on communication with the Catalina Islands, California, a distance of about 3,000 miles. Nightly communication has been carried on over distances ranging between 300 and 1,200 miles. The voice (antenna current 1 ampere), with two oscillators and two modulators, has been

heard as far south as Orlando, Florida, as far east as Philadelphia, as far north as Michigan and as far west as Kearney, Nebraska. A few years ago 8LF was using a 1 K.W. spark transmitter with an input to the antenna of 246 watts; on the C.W. set (the same set as is described here), the total input is 46.8 watts. Six times the distance has been covered with 200 watts less input. Efficiency on the spark transmitter was about 12 percent and on C.W. nearly 60 percent.

A detailed description of this set is of more than casual interest to the amateur.

The antenna system is composed of six parallel wires spaced 3 feet apart and 65 feet long, suspended at the far end on a ship mast affair on top of a telegraph pole, planted in the rear of the residence. The other end is supported by a mast on top of the house, both 45 feet above the ground. This antenna system has a low natural period and also low resistance, operating most efficiently at approximately 200 meters.

All panels are made of ¼-inch bakelite. The front panel is 14 inches by 18 inches, the main shelf 10 inches by 14 inches and the sub-shelf is 4 inches by 14 inches. Mounted on the main panel is an antenna meter in the center (at the top). Holes 1½ inches in diameter are drilled for peep holes for each tube, and as the shelf is mounted on micarta uprights 10 inches from the top of the main panel, the alignment of the holes should be such as to permit a proper vision of the active elements of the tubes, plate, grid, and filament. The rheostats for the filaments are mounted under each peep hole.

The general position of all knife switches is shown in Figure A. Two

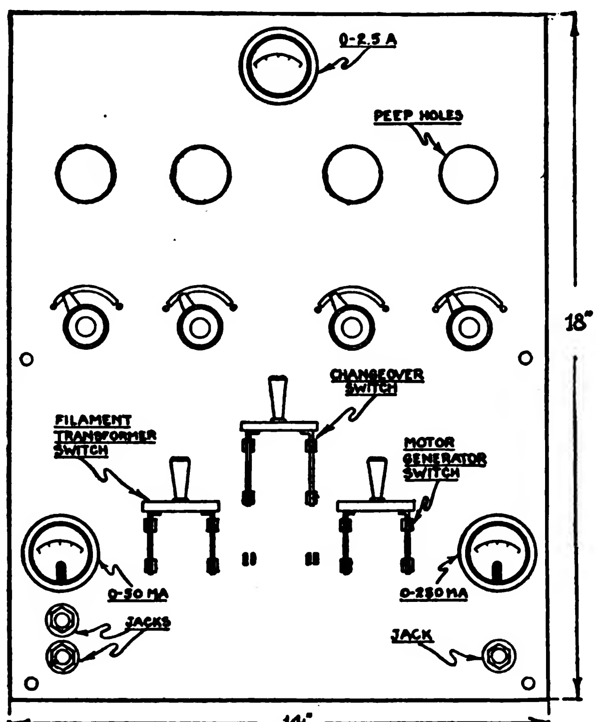
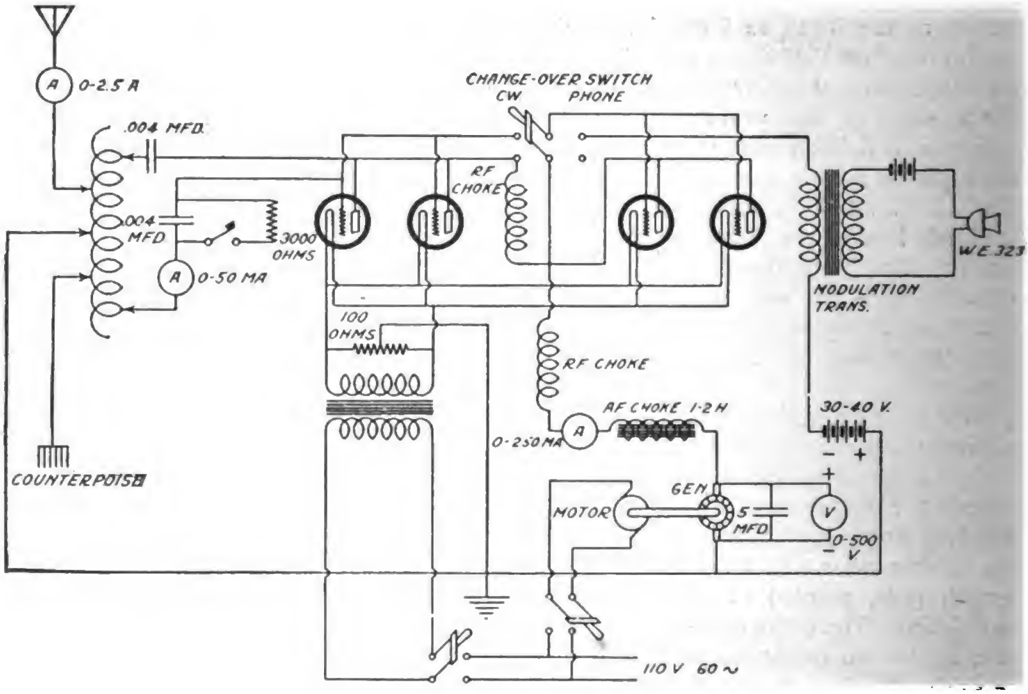


FIG. A

This diagram shows the layout for the front panel of the transmitting apparatus illustrated on the opposite page.



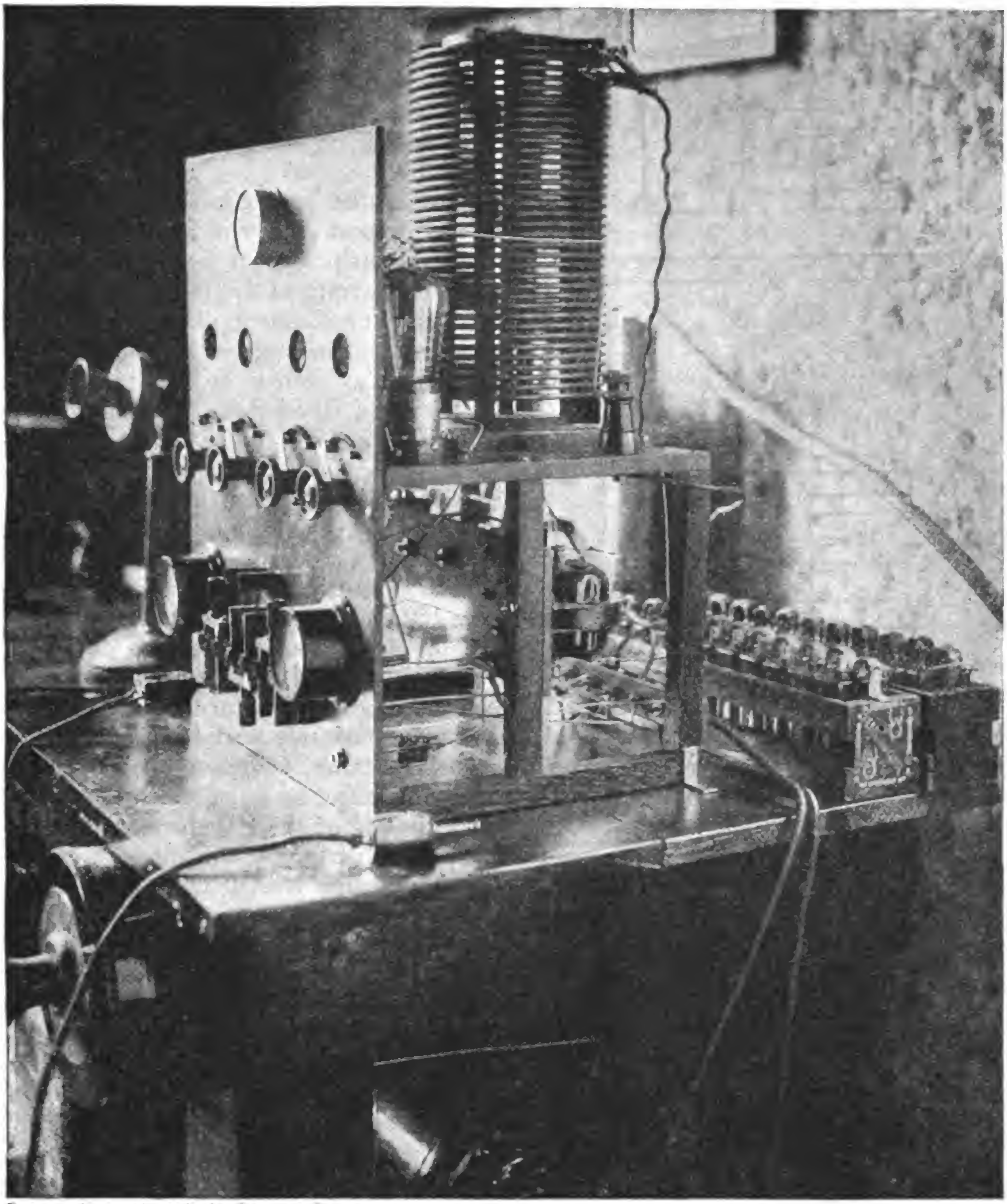
THE WIRING DIAGRAM OF THE THOMAS SET

Circuit diagram for 4-5 watt tubes, using Heising modulation for voice. The tube filaments are heated by a step-down transformer operated off the 110-volt A.C. lines. The motor-generator, which supplies the high-voltage direct current for the plate circuit of the tubes, is also operated from the same power source. A switch is provided for using all four tubes as oscillators, for C.W. telegraphy—in which case the telegraph key in the grid circuit is used in forming the code characters.

milliammeters should be incorporated in the set—one to register the grid current (full scale deflection 50 milliamperes) and another to register the total plate current (full scale deflection 250 milliamperes). Three jacks and two plugs are used. With this arrangement the use of but one telegraph key is necessary. One of the plugs is connected to the key, which, when plugged into the upper jack on the lower left-hand side of the panel, will make and break the 6-volt circuit to the buzzer and when plugged into the right-hand jack on the panel will make and break the grid leak circuit for continuous wave transmission. The other jack is connected to the modulation transformer. The microphone is connected to another plug which should be inserted in the lower left-hand jack.

On the main shelf are mounted four sockets and the inductance coil and the buzzer. The inductance is 7 inches in diameter and 9½ inches high; it is wound with No. 10 bare copper wire, 35 turns ¼ inch apart. The wire is wound into grooves cut in the bakelite uprights and fastened securely at both ends. The builder can readily devise some sort of suitable connection clip for No. 10 wire.

On the small sub-panel placed under and parallel with the main panel and mounted on another set of brackets are the modulation transformer, grid condenser, grid leak, plate condenser, audio frequency choke coil and two radio frequency choke coils. The grid condenser is made up of seven pieces of copper foil .002 inches by 1½ inches by 2½ inches, as conductors, with thin strips of mica as dielectric, pressed and immersed in boiling paraffine. For the grid leak a Ward-Leonard resistance tube of from 3000 to 5000 ohms resistance is used. The plate



From a photograph made for POPULAR RADIO

A CLOSE-UP OF THE THOMAS TRANSMITTER

This is the apparatus on which 8LF has communicated from his home in Pittsburgh to stations as far west as 2,750 miles off the Pacific Coast. This view of the set gives a comprehensive idea of the general assembly of the panels and the bracket supports. The oscillation transformer and tubes are mounted on the shelf, and the modulation transformer and choke coils are fastened to the back panel. The binding post strip is also shown attached to the two rear wooden supports.

condenser is a .25 mfd. condenser, but any condenser that will stand the plate voltage is suitable; in fact, a duplicate of the grid condenser will be entirely satisfactory. This condenser prevents a short on the generator in case the antenna

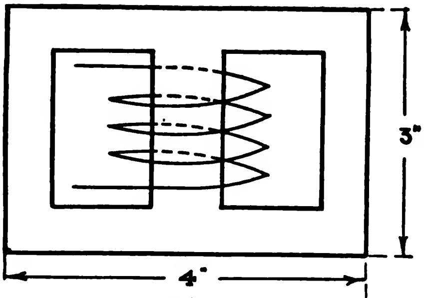


FIG. B

The dimensions for the iron core of the audio frequency choke coil.

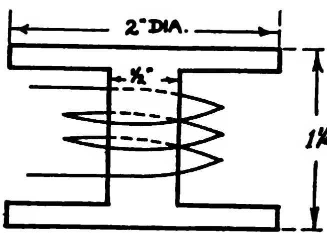


FIG. C

Dimensions for the wooden spools upon which the radio frequency choke coils are wound.

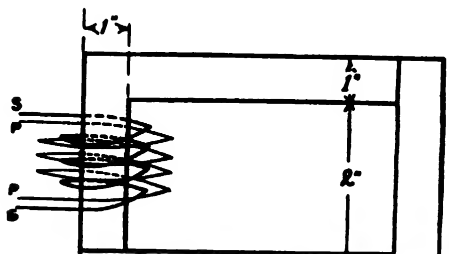


FIG. E

Dimensions of the iron core for the filament lighting transformer.

should accidentally become grounded.

The audio frequency choke coil is made up of approximately 3,000 turns of No. 30 DSC wire wound on a micarta square tube that fits snugly over the center leg of iron punchings, the dimensions of which are shown in Figure B. Both of the radio frequency choke coils are wound on micarta spools, the dimensions of which are shown in Figure C; they should be wound full with No. 30 DSC. These spools do not necessarily have to be made of micarta, but may be constructed of cigar box wood treated with paraffine.

Across the back micarta uprights that help support the shelves is bolted a micarta strip 1 inch by 14 inches, on which is arranged the necessary binding posts for the filament, plate, grid, buzzer, and microphone current supply; they are arranged as shown in Figure D. All condensers, choke coils, filament heating transformers and other parts are available on the market.

Experiments have been made with various sources of plate supply; the most satisfactory is the motor-generator, which is a direct-coupled affair, delivering 150 watts at 400 volts. The filament supply is obtained by stepping down the 110-volt, 60-cycle current to 7 to 8 volts by means of a transformer. Across the secondary of this transformer is a 100 ohm resistance, center-tapped to obtain the same effect as actually center-tapping the winding of the transformer. A suitable transformer for this purpose can be made by using No. 10 DCC wire as the secondary with 32 turns and No. 22 DCC as the primary with 400 to 440 turns, tapped for variation of voltage. The secondary winding is placed nearest the core, being wound on a square tube, 2½ inches long, and the primary winding is placed directly over this winding, the core being assembled in a square "O" shape. There are so many suitable transformers on the market for this purpose that anyone who is unable to obtain satisfactory punchings for the core would hardly be justified in attempting to construct it; however, Figure 3 shows a transformer that is suitable for supplying one to five tubes with current for operation. A 1,000-volt, 5 mfd. condenser should be placed across the generator or plate supply and one audio-frequency choke coil connected in series with the generator. This forms an effi-

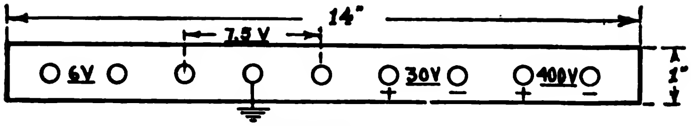


FIG. D

Diagram of the strip of micarta upon which the binding posts for the battery connections are mounted.

cient filter for doing away with the commutator ripple.

The entire set is wired with No. 14 solid bare copper wire in accordance with the diagram shown in Figure F; with proper care in wiring, and assuming that the antenna system is suitable, the antenna current should be approximately 2.5 amperes, using four tubes as oscillators on 200 meters. For transmitting the voice, two tubes should be used as oscillators and two tubes as modulators; the antenna current should be 1 ampere or more.

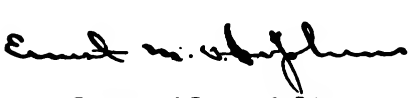
Any amateur who builds a set from this description will presumably attain results similar to Mr. Thomas'—providing, of course, that his antenna system is adequate and that the local conditions are favorable.

¶ How many radio fans know just what is the difference between a "hard" tube and a "soft" tube? How many know the specific uses for which each is designed? In the next issue of this magazine—JANUARY—Prof. William C. Ballard, Jr., of Cornell University, will answer these questions; incidentally he will give the amateur other information of practical helpfulness.

Radio as a Power for Educating the People

TO THE EDITOR OF POPULAR RADIO:

"It seems to me that there are undreamed-of possibilities for the utilization of radio broadcasting in the interest of educating the public. I think the mistake is too frequently made of thinking that education can be secured only through formal institutions of learning. Of course, the fact is that any open-minded individual is becoming more educated all the time simply by the use which he makes of the accessible opportunities of life; and many a man of acquisitive mind acquires a better education by himself than many another does, even with the assistance of one of our foremost colleges or universities. If a broadcasting program could be devised and made available under the guidance and direction of a group of men free from any suspicion of pleading for special causes, it would be a tremendously valuable contribution to raising the general level of intelligence and culture."



President of Dartmouth College

HOW TO SELECT

The Best Coil for Your Set

By PROF. J. H. MORECROFT

From a photograph made for POPULAR RADIO

In this article the author, who is one of the foremost radio experts in the country and a member of the faculty of Columbia University, tells the radio amateur what his coil really does and points out how he may determine the particular kind that will best serve his particular purpose.

IT would seem that such a simple thing as a coil could require but little analysis; that anyone could build a coil which would prove satisfactory when used in a radio circuit. Of course anyone *can* build a coil which will operate in a radio circuit; the question is—how good is the coil and how well will it operate compared with the best coil which can be built for the purpose?

It is the purpose of this article to point out some of the factors which determine just how good a coil is and how well it should function.

There are three so-called electrical constants which enter into all of our calculations in radio work; not only enter into our calculations but which also determine completely how well a set may operate. They are:

The inductance;
The capacity;
The resistance.

Resonance is, of course, the key-note of operation of all radio circuits; the product of the inductance and capacitance used in the circuit determine at what frequency resonance is obtained. The sharpness of this resonance (that is, the relative ease with which it lets through the desired frequency as compared with others of different frequencies not desired) is determined by the ratio of the resistance of the circuit to its inductance.

It is evident that the characteristics of a coil, simple thing as it is, are well worth while studying; this study soon shows that resistance and inductance at radio frequencies are not the simple

things taught in elementary physics, but are rather complicated—so much so that theory alone cannot predict what the constants of a coil will be at high frequencies, so that recourse must be had to experimental determination.

The student of electricity learns that if the voltage (in volts) of a continuous current circuit is divided by the current (in amperes) which flows through a circuit, the quotient will be the resistance of the circuit (in ohms), and that this resistance is constant unless the temperature changes. In an alternating current circuit the same quotient yields the impedance of the circuit, the impedance being made up of two components, resistance and reactance. If the current lags behind the voltage, in phase, the reactance is inductive; if the current leads, it is capacitive. The resistance of the circuit is not the same value at all as would be determined by continuous current test, using Ohm's law for its calculation; in fact, a circuit which shows millions of ohms resistance to continuous current flow may have only a fraction of one ohm for a high frequency alternating current.

As Ohm's law does not suffice to determine resistance in an alternating current circuit we must get a new definition which does meet the situation. This definition, which is applicable to all circuits for continuous as well as for alternating current (that is, it includes Ohm's

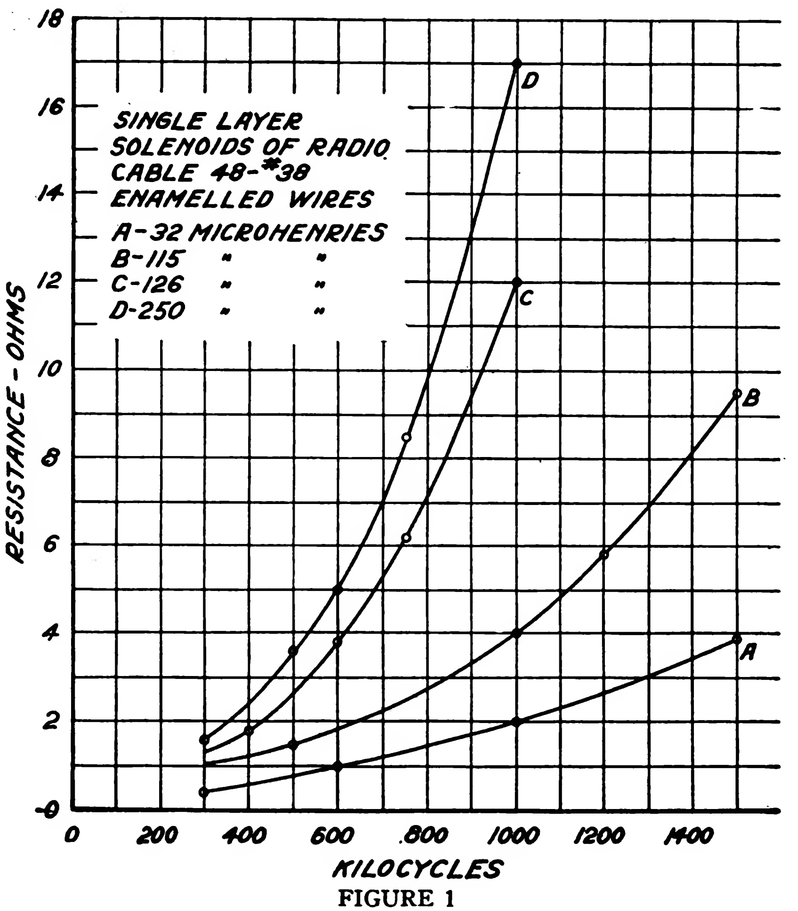


FIGURE 1

A resistance-frequency chart of single layer solenoids of different values of inductance.

law as a special case) is

$$\text{Resistance} = \frac{\text{Power used in the circuit}}{(\text{current flowing in the circuit})^2}$$

If the power is given in watts, and the current in amperes, the resistance will come out in ohms.

It might be questioned how this definition can be used in radio circuits—can we use a watt-meter to read the power used? The answer is "no"; the procedure indicated by the definition does determine the resistance but is not generally followed. We could put the circuit in a calorimeter, measuring the rate at which heat is developed, divide the amount of this heat by the square of the measured value of the current flowing, and so determine the resistance; but such a method is not suitable for rapid and accurate determinations.

It is possible to so adjust the circuit that its reactance is zero, in which case the resistance is given by Ohm's law.

$$R = E/I$$

In another method the alternating current Wheatstone bridge is used, by which the resistance and reactance of the coil are both determined at once when the bridge is balanced. The bridge is probably not accurate however at more than a few hundred thousand cycles a second so that the resonance method (making the reactance equal to zero) is the only one available.

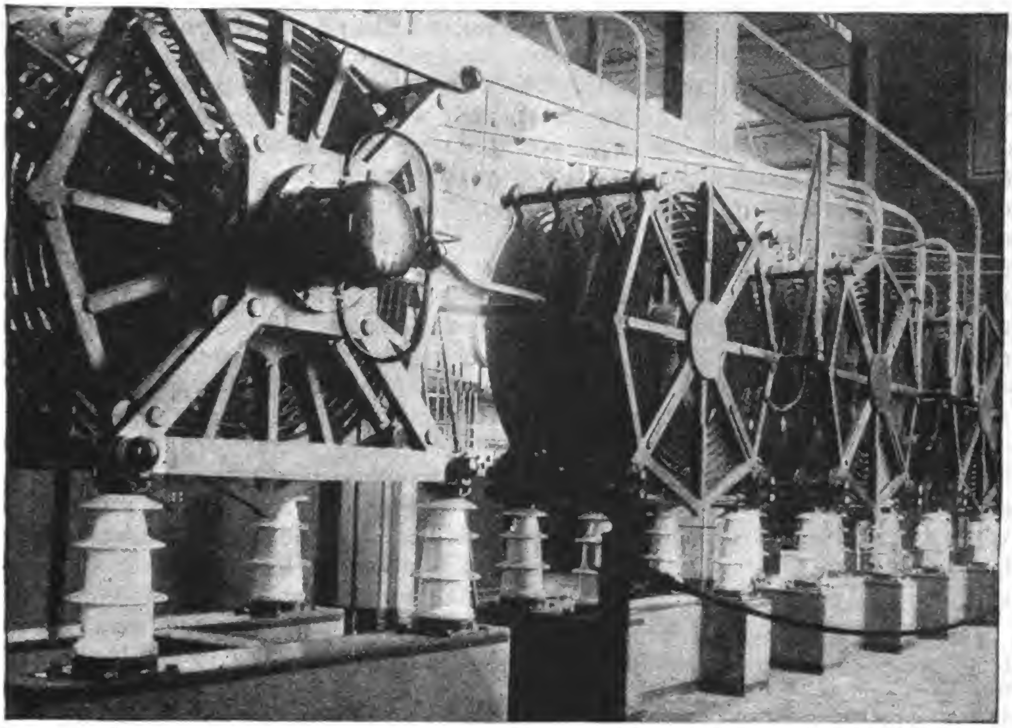
If the frequency of the power supply is known (as it will be by wavemeter determination) and the capacity used in the circuit to establish resonance is accurately known, the inductance of the coil, as well as its resistance, is determined by the resonance test. So with a good wavemeter, and a well built and carefully calibrated condenser, with suitable thermocouples for current measurement, resistance and inductance measurements may be made with a fair degree of accuracy for frequencies as high as ten million or more.

This article gives the results of a few measurements made by the writer in such a fashion; from these results certain conclusions may be drawn which are interesting to the radio enthusiast. By the radio enthusiast is meant the one who is interested in knowing *why* certain things are as they are, not the one who merely boasts that he furnishes the neighborhood with so much noise from his set that the police department have to censor him, or the one who hears so many distant stations that actually do not exist. Recently the writer received two letters from the enthusiastic West giving in detail conversations which some amateur had heard over his phone set; these conversations took place when the transmitting station was closed tight under lock and key.

Why should the resistance of a coil be different at radio frequencies than for continuous current?

There are many things resulting in an increase in resistance for the high frequency alternating current which do not exist at all for continuous current or very low frequency alternating current. For continuous current all of the cross-sectional area of the conductor is useful in carrying current, whereas for high frequency, due to what is called the skin effect, but a small part of the copper may be useful in carrying current. The losses in bits of metal used in the construction of the coil (for terminals, for example) change the effective resistance of the coil, always making it greater than it is for continuous current. The material on which the coil is wound is in a high frequency electric field, and even though it be a perfect insulator, permitting no current at all to leak from one turn of the coil to the next, it is subject to losses called "dielectric losses," or "dielectric hysteresis." This loss increases directly in proportion to the frequency and so may give a substantial increase in the effective resistance of the coil at the high frequencies used in radio.

It might be thought that this change in effective resistance with increase of



International

GIANT LOADING COILS IN THE RADIO STATION AT NAUEN, GERMANY

The amateur, who deals with electrical powers which are infinitesimal in comparison to those used for trans-oceanic telegraphy, should be careful to use coils that will squeeze out into the antenna even that last little fraction of a watt that is trying to find a small hole to sneak into and peacefully sleep, instead of being shot out into cold space

frequency is not worth bothering about—perhaps a few per cent. But such is not the case; the resistance for high frequency alternating current may be many times as much as it is for continuous current. Thus one coil such as might be used in an ordinary receiving set had a continuous current resistance of 0.45 ohms; at 500 meters wavelength it had 3.5 ohms, and at 200 meters it had 18 ohms. In other words, the coil had forty times as much resistance as the wire table for resistance of copper wires would predict. This was not a defective coil, but a good single layer solenoid of No. 20 solid copper wire.

To show how the resistance of coils varies with frequency the curves of Figure 1 are given; they are experimentally determined curves for ordinary solenoids such as are used in receiving sets of the better class. The wire of which the coils were made was of radio cable, made of 48 strands of No. 38 enameled copper wires properly bunched together. Up to frequencies above one million cycles a second the cable shows itself superior to solid wire, as the solid wire has not the same cross section as the cable but is of such a size that it winds the same number of turns to the inch. The continuous current resistance of the solid wire was only about one-half as much as that of the cable, showing there was more copper in it than there was in the cable. Above one million cycles, however, the solid wire actually becomes better than the much more expensive cable, or "litzendraht," as it is sometimes called.

The superiority of the solid wire is well shown in Figure 2, which gives the

resistance of solid wire and cable coils of the proper number of turns to make them suitable for short wave sets. It will be seen that at the higher frequencies the solid wire has less resistance than the cable, although at the frequency used in broadcasting (about 833,000 cycles) the cable is considerably the better of the two. As to just where the solid wire becomes better than the cable will depend somewhat upon the form of coil; the conclusions reached from these curves holds only for coils of similar shape and method of winding. It is comforting for the amateur who "builds his own" to know that the cable, costing about twenty times as much as the solid wire, and which is also troublesome to tap, is but little better than the cheap, easily worked solid wire.

For a given type coil, wound of a given kind of wire, at a specified frequency, there is one coil which gives a better performance than one with either more or less turns; that coil having the greatest ratio of reactance to resistance will tune best, be most selective; to get this highest ratio a coil with the proper number of turns must be used.

Using two and three layer banked winding solenoids, made of radio cable (48-38's), the ratio of reactance to resistance was found for various coils as given in Figure 3. The coils were all of the same diameter (about 4 inches), and the length varied with the number of turns used. These curves indicate that to get the best tuning (greatest selectivity) a proper coil should be used for a certain wavelength. Thus, for tuning to 500 meters we should use coil A in preference to any of the others, but for 800 meters practically all of the coils are equally good. It must be borne in mind that the conclusions drawn from these curves, while in general correct for any form or type of coil, hold specifically true only for coils of this size and wound with the kind of wire used here; also that the losses in the condenser used in conjunction with the coil for tuning must be considered. In general if two coils have the same ratio of reactance to resistance, that with the smaller inductance is preferable, as it will require a greater capacity for tuning and the effective resistance of a variable condenser always decreases with increase of capacity.

The resistance of the loading coils used in transmitting sets is an extremely important factor in the efficiency of the station. Unfortunately the requirements for tuning, as at present carried out, practically require that a coil of heavy copper strip be used so that clips can be moved along them for adjusting the wavelength. The resistance of these coils is excessively high at radio frequencies. In one coil of heavy copper strip measured by the writer the resistance at 3000 meters was 350 times as much as its continuous current resistance; at 200 meters it would have been thousands of times as great as one would think, looking at the amount of copper used. In a certain one-kilowatt transmitting station the loading coil got so hot that it was uncomfortable to touch; it seems likely that two or three hundred watts were being used up in this coil, an amount of power which required an investment of perhaps $200 in tubes to generate. It seems advisable to build the loading coil of heavy radio cable, of the proper number of turns to tune the antenna to a slightly lower wavelength than it is desired to radiate, and bring the circuit up to the desired wavelength by putting a good variable condenser in parallel with the antenna. If the loading coil of your transmitter gets appreciably hot it is a safe guess that the coil has a very high resistance and is inefficient.

The coefficient of self-induction of a coil may be easily calculated when the dimensions of the coil and number of turns are given. If the coil is measured at, say, 1000 cycles the calculated value of L will be found the same as the measured value, generally closer than 1 per cent. If, however, the coil is measured at radio frequency the inductance may be

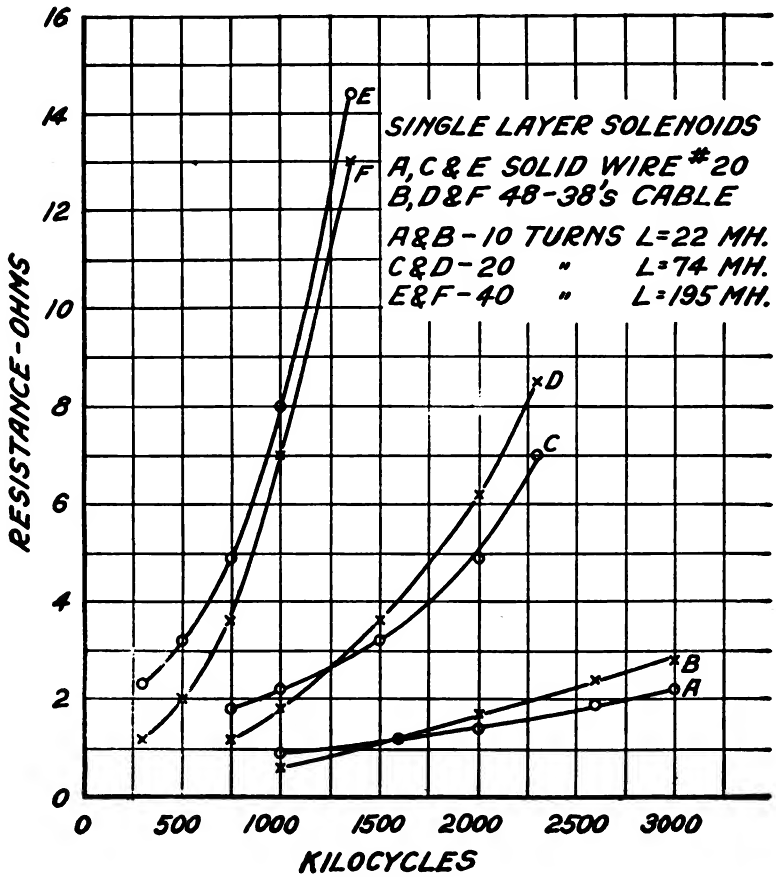


FIGURE 2

Another resistance-frequency curve for coils wound with No. 20 wire.

found either slightly less or considerably more than the measured value. And in the extreme case what is evidently a coil measures up as a condenser!

The reason that the measured value of L may come out smaller than the calculated value is because of the shift of the current from a more or less uniform distribution throughout the cross-section of the wire at the low frequency, to a crowding to that side of the wire which is closer to the axis of the coil at radio frequencies. As this shift in the current is equivalent to a decrease in the radius of the coil, of course the measured value of L is smaller than the calculated one, as the formula assumes a uniform distribution of current. If radio cable is used in constructing the coil this effect cannot occur, so the value of L does not show a decrease as the frequency is raised; the effect occurs to the greatest extent in the strip coils used for transmitting loading coils.

The apparent increase in inductance with increase in frequency exists in all coils, no matter how they may be built, and does result in an increase in the measured value of L at the higher frequencies, no matter with what kind of wire the coil is wound. In the solid wire, or copper strip coil, therefore, we may expect the inductance to decrease slightly at first as the frequency is raised and then to increase, whereas with cable wound coils the measured value of L will show a continual increase in L as the frequency is raised. This increase

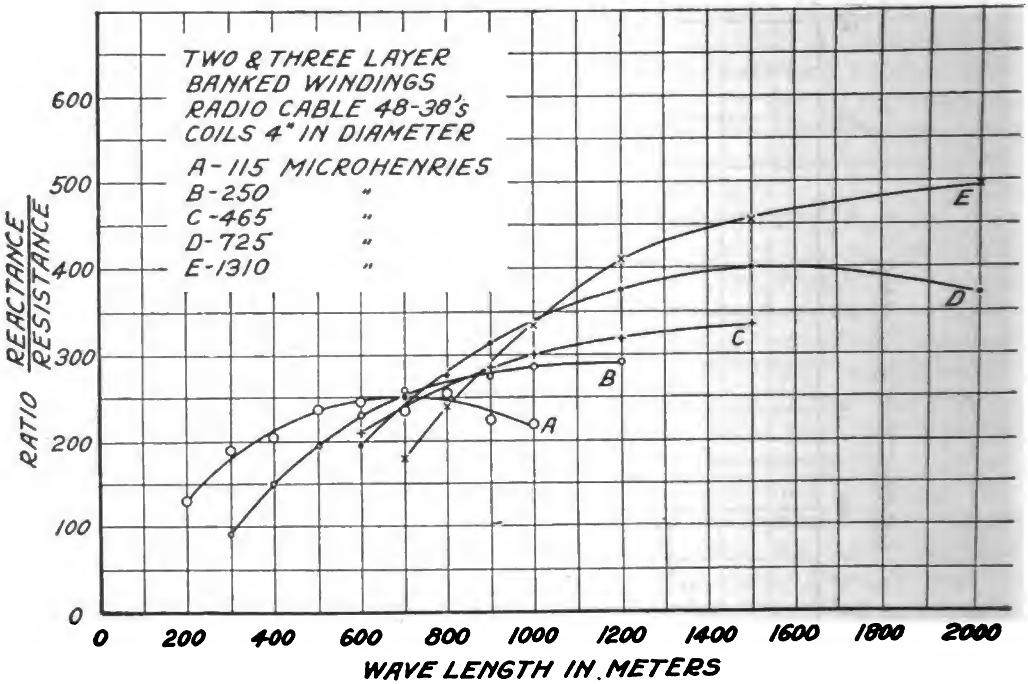


FIGURE 3

This chart shows the ratio of reactance to resistance for two and three layer bank-wound coils at different wavelengths.

is due to the distributed capacity of the coil itself. Each part of the coil acts with every other part to form a kind of complicated condenser, so that the coil really should be represented as a coil in parallel with a fixed condenser, the capacity of this condenser being equal to the distributed capacity of the coil. This representation is not complete because actually the capacity of the coil changes with frequency, an effect which is generally neglected in treating the theory of coils.

The effect of this distributed capacity is, in general, not detrimental, but may be so if the capacity is comparable to that used with the coil for tuning purposes. In this case, as the capacity of the external condenser is only a part of the total effective capacity in the circuit, variation of its value does not accomplish tuning as sharply as if there were no capacity of the coil affecting the circuit.

It might seem that distributed capacity in a coil is not objectionable, as we have to have a condenser connected to the coil anyway—for tuning purposes. But such is not the case. It is best to keep this capacity as small as possible because the dielectric used in that capacity is poor compared to the dielectric used in the external condenser. The distributed capacity of the coil has cotton, paper, shellac, or enamel, for its dielectric, whereas the regulation tuning condenser is a very well built air condenser, and air is far superior to any other substance as a dielectric; it has no losses at all.

The various turns and layers of a coil should be kept reasonably far apart if the distributed capacity is to be kept low, and the dielectric between layers and turns should be air, if possible. Several years ago the writer showed how such a construction could be carried out without too much difficulty. Using air for the dielectric between layers has the double advantage of low specific inductive capacity and also prevents leakage of cur-

rent in passing from one layer of the coil to another.

Many times a solenoid is furnished with many taps and a multipoint switch for tuning purposes; although this is a convenience it does not give as good results as a single coil of the proper number of turns. This is especially true if but a small fraction of the coil is to be used, say a quarter or less. In such cases the coil acts as an auto-transformer, the unused portion having comparatively high voltages induced in it and thus producing large unnecessary copper and dielectric losses in the unused portions. Also it is evident that the switch points mounted in the panel of bakelite or similar material constitute a condenser in parallel with the tuning condenser; in this connection it should be borne in mind that losses in the bakelite, or leakage across from one point to another, is, of course, just as detrimental as leakage in the coil itself.

To prevent the losses in the unused portion of the coil it is best to build the coil in sections, an inch or more apart; many times it will be found advantageous to short-circuit that part of the coil which is not being used. This is especially true when but a small part of the coil is being used. Although there will be eddy current losses in the short-circuited part of the coil these losses may be less than if the coil were not shorted. There will be practically no dielectric losses in the unused parts of the coil, because the voltage in these parts will be low; and furthermore it is quite possible that there will be less current in the unused part than if it were not shorted, strange as this may sound. If there are several sections in the unused portion of the coil it will not be necessary to short all of the unused part; shorting the section directly next to that part of the coil which is being used is, in practically all cases, almost as satisfactory and as a matter of fact it is in general easier to accomplish.

George Grantham Bain

Radio's Chance to Render a Distinguished Public Service

To the Editor of Popular Radio:

"I entirely approve of your plan of extending the radio broadcasting program for educational and cultural purposes. It is a forward step in our civilization and the commencement of a very important movement to give the world at large a chance to participate in entertainments, instruction, musical programs and lectures, which heretofore could only be given to a comparatively small number, being limited to the space which could be given the audience in a building. By now being broadcasted they are opened up to a large public all over the world; in fact, to whoever wants to take advantage of the opportunity offered."

Adolph Lewisohn

Donor of the Stadium of the College of the City of New York

From a photograph made for POPULAR RADIO

THIS HOME-MADE SLIDING COIL COST 50 CENTS

A loading coil may be made either with a sliding contact for adjustment or the coil may be tapped. The coil described in this article is of the latter type.

How to Make and Use A LOADING COIL

The Seventh of the Popular Series of "How to Make" Articles for the Radio Novice

By A. HYATT VERRILL

FEW of the more simple devices used in radio telephony are less understood and less appreciated by the average novice or beginner than the loading coils. In the columns of questions and answers in the radio periodicals a large proportion of the queries seek information about the distance at which a set can receive and the use of loading coils to bring in signals.

The idea that the use of a loading coil will increase the distance at which a set can bring in signals appears firmly fixed in the minds of many radio fans who apparently do not understand that wavelength and distance have very little to do with each other. The wavelength is merely the length of the radio wave, and the shortest wave may travel completely around the earth, although it might not be possible to detect it with the instruments we now have. On the other hand, the best of sets might not pick up an extremely long wave message, even though the set were within a couple of miles of the sending station; whether or not a wave of a certain length is received depends as much upon the wavelength range of the set as upon its distance from a sending station.

Also, if the set can be tuned or adjusted to the desired wavelength the distance at which it can bring them in depends entirely upon its sensitiveness

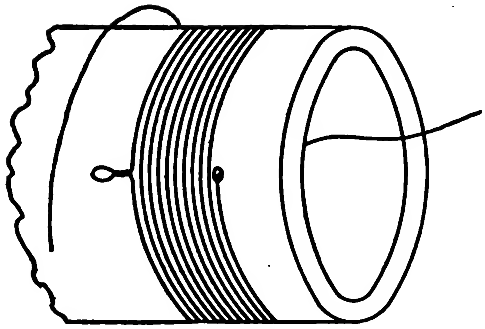


FIGURE 1
This diagram shows how a tap is made.

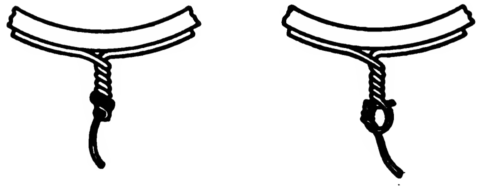


FIGURE 2
How a connecting wire is joined to a tap. The wire is twisted around one side of the loop and then the whole is twisted together.

and has nothing to do with the wavelength.

Hence the novice should remember that when he adds a loading coil to his set it merely increases the wavelength or the size of waves which can be received and does not increase the distance at which a signal may be received. It must also be borne in mind that different types or forms of loading coils must be employed with different types of sets. If you are using a set with a single circuit and a simple inductance, a single primary coil loading coil may be used. If you are using a double circuit set with a primary and secondary or coupled inductance then to obtain the best results the loading coil must also be a double or coupled coil.

A loading coil in effect is simply an extension of the aerial circuit; by adding it to your set you merely increase the wavelength of your aerial circuit by adding to the inductance already in the set. Loading coils also are made in various forms. Some of them are of large diameter and narrow surface; others are long and cylindrical. The latter form is the simpler to make.

Also, the longer the loading coil and the more turns of wire upon it the greater the wavelengths which may be brought in. As few amateurs wish to pick up the very longest waves, however, a coil which will bring in waves up to 5,000 meters is amply sufficient.

To make such loading coil—to be used with a single circuit set—is a simple matter; an excellent coil may be constructed at a cost of far less than you would pay for a ready-made coil. No special tools are required and the materials needed are few and inexpensive.

For a coil to load up to about 4,000 meters you will need a tube of formica or some similar composition, about one foot in length and four inches in diame-

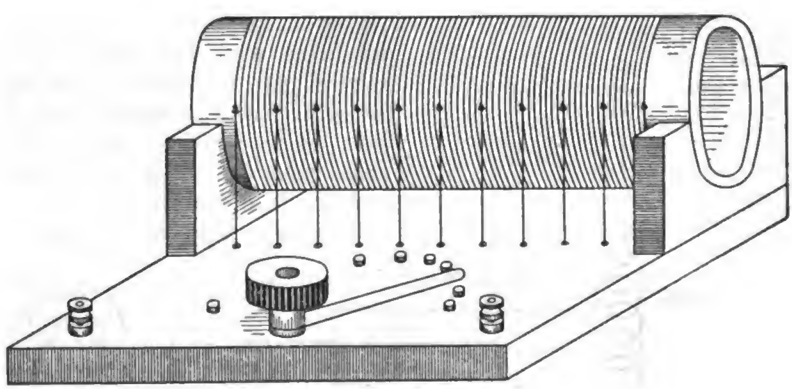


FIGURE 3
This is how the completed coil looks when it is mounted on a base-board.

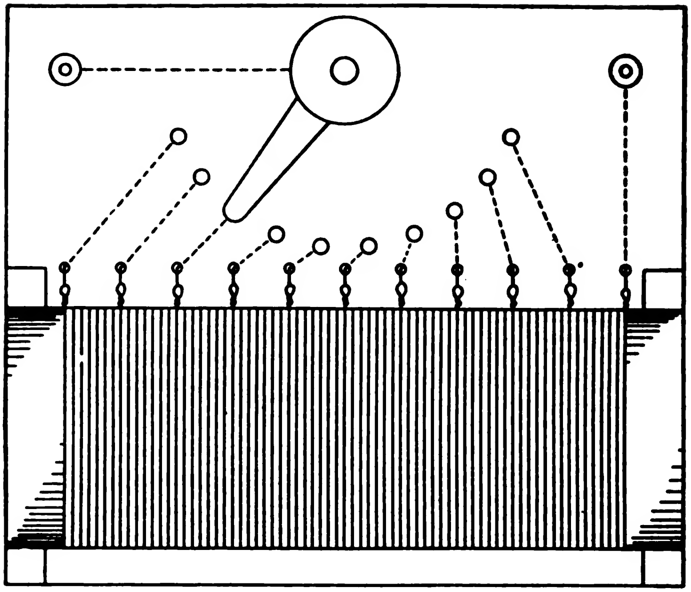


FIGURE 4

A plan view of the coil, showing how the switch joints, switch blade and binding posts are wired beneath the base-board.

ter, a ten point multiple switch; binding posts; some cotton or silk insulated No. 20 or 22 copper wire and a base or panel of wood or bakelite on which to mount the coil.

If the coil tube is one foot in length it will take practically 250 turns of wire, leaving half an inch bare at each end for attaching or mounting the coil.

Begin by making a small hole half an inch from one end of the coil. Run an end of the wire through this hole with six or seven inches projecting and fasten it to the inside of the tube by means of sealing wax. Then wind on the wire smoothly and evenly, keeping the turns close together until you have wound on twenty-five turns. Make a loop or tap in the wire (see Figure 1) and continue winding for another twenty-five turns. Here another tap should be taken and the winding should proceed, taking a tap at each twenty-five turns until the wire has covered the coil to within half an inch of the other end, when it should be passed through a small hole as in starting and secured in the same manner. This will give you nine taps and the loose ends.

The next step is to scrape carefully

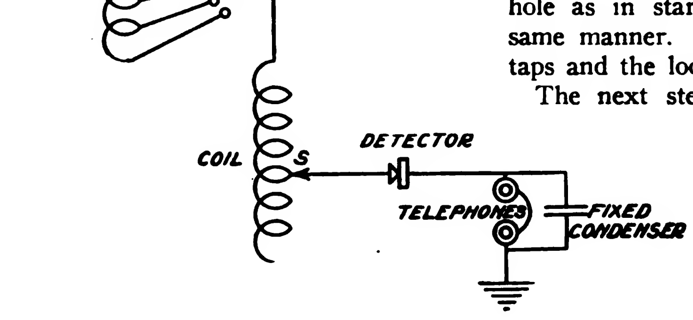


FIGURE 5

How the loading coil is connected in a single circuit receiver.

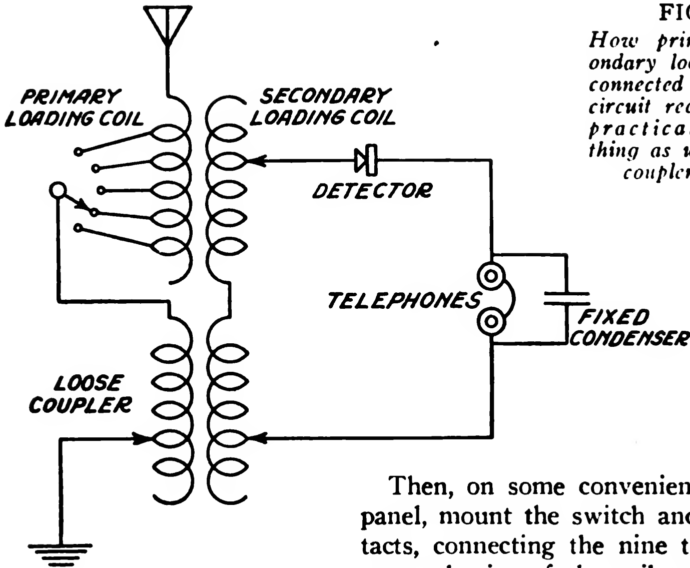


FIGURE 6
How primary and secondary loading coils are connected in a double circuit receiver. This is practically the same thing as using two loose couplers in series.

the insulation from the tap loops, clean the exposed wire and twist in a six or eight-inch length of wire in each loop. By twisting the wire around one side of the loop and then twisting the whole together (see Figure 2), a good connection may be made, but as soon as all have been thus twisted in you should go over them and solder the wires. Then slip a section of varnished cambric tubing over each tap and wire so as to completely cover the exposed copper.

The coil should then be mounted on a base or panel by using two uprights or supports, each with a half circular opening cut in them, as shown in Figure 3. The bare ends of the coil should rest in these and should be secured by means of small brass screws through the coil from the inside. Place these screws as close to the ends of the coil as possible and use as few and as small screws as will secure the coil firmly.

Then, on some convenient part of the panel, mount the switch and switch contacts, connecting the nine tap wires and one end wire of the coil to the ten contact points. Then connect the switch arm post to a binding post and lead the other end wire of the coil to a second binding post as shown in Figure 4. The coil is then ready to use; this is done by running your lead-in to one binding post and connecting the aerial terminal of your set to the other binding post as shown in Figure 5.

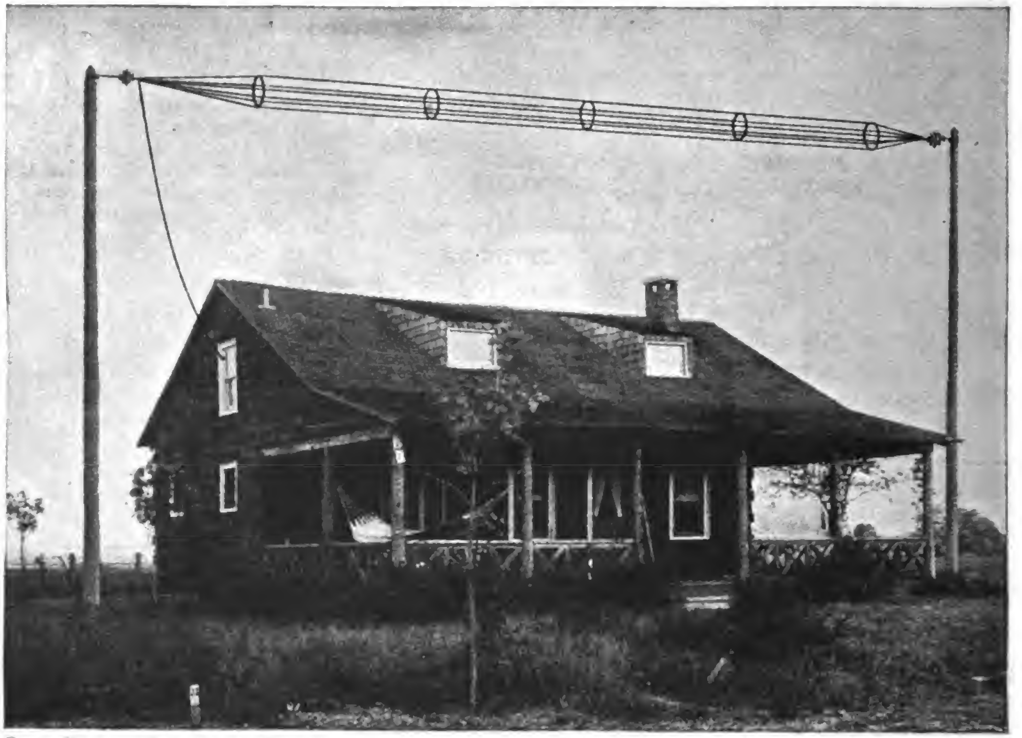
In tuning for the longest waves place the switch "S" at the loading coil end. Then move the loading coil switch to the proper point and do your finer tuning with the regular coil.

If your set uses a coupled coil the loading coil is a trifle more difficult to make, for it must consist of two inductances, one a trifle smaller than the other and placed within the other, each tapped and arranged to connect in series with the corresponding inductances on your set. (See Figure 6.) The same methods are followed in making these inductances.

To the Editor of Popular Radio:

"I should think that a project such as yours for improving the quality of the radio programs ought to have the heartiest support. . . . It would certainly be worth while for the college to install a complete receiving and amplifying set in one or more of the college auditoriums, if such programs as are suggested could be received."

George H. Nettleton
Acting President of Vassar College



From a diagram made for POPULAR RADIO

AMATEURS HAVE SENT AND RECEIVED TRANSATLANTIC MESSAGES WITH THIS TYPE OF ANTENNA

As the amateur is limited to transmission or low wavelengths a highly efficient antenna is a prime necessity. This is the best for his purpose.

The Best Antenna for Transmitting

THE CAGE TYPE

The Third of a Series of Short Articles on the Antennae Best Adapted for the Amateur's Uses

By DAVID LAY

THE cage type of antenna is meeting with increasing popularity among the advanced amateurs, especially with those amateurs who are trying to establish new records for transmitting. In view of the fact that the amateur is limited to small power for transmitting purposes, any increased efficiency that can possibly be obtained in the apparatus that he uses is of the utmost importance.

The ordinary flat-topped antenna uses four wires, the outside wires carrying more current than the inner wires; or in other words, the outside wires are worked at a higher efficiency than the inner wires. That this is so is shown by the comparison of electrostatic fields around the different wires of such an antenna. A cross-sectional view of these fields is shown in Figure 1. It will be noticed that the two outside wires 1 and 4 have more lines of force connecting them to the ground than the two inner wires 2 and 3. This of course indicates that there is more current flowing in the outer wires than in the inner ones, and this difference in current can be determined by actual test.

In the cage type of antenna the wires

are not spaced in a plane or flat top but are arranged in a circle, as shown in the diagram in the photograph. In an antenna of this design the currents flowing in the antenna wires are more evenly distributed; even the top wire has the same current as the lower ones.

In Figure 2 is shown a diagram of the electrostatic field that surrounds a cross-section of a cage type of antenna. Notice that all the wires have approximately the same number of lines of force attached to them. In this type of antenna all the wires are worked at the same efficiency.

This type of antenna also gets its increased efficiency because of its tubular shape, for it is well known that the metallic tube is the most efficient conductor of high frequency currents.

In building such an antenna it is advisable to cut the wires the correct length and lay them on the ground. If a six-

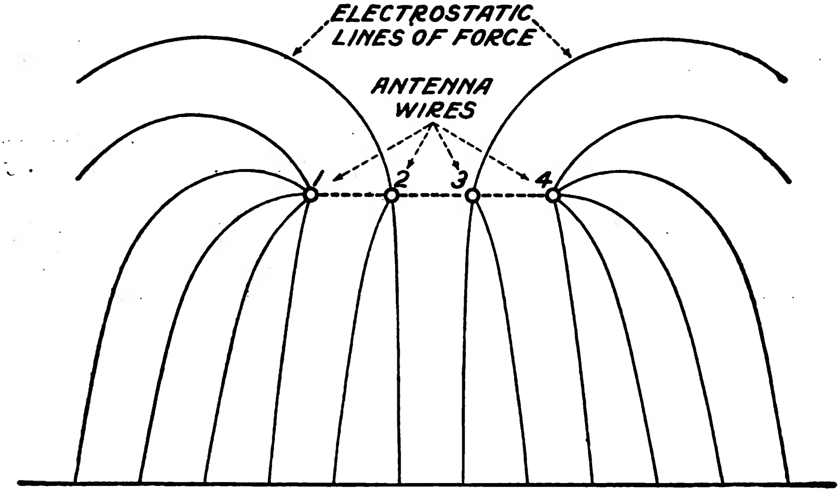


FIGURE 1

The potential gradient around the end wires 1 and 4 in a flat-top antenna is much greater than the middle wires 2 and 3. This is evidenced by the crowding of the electrostatic lines of force around the outer wires. In other words, the two outside wires do most of the work and the top side of the antenna does hardly any work at all.

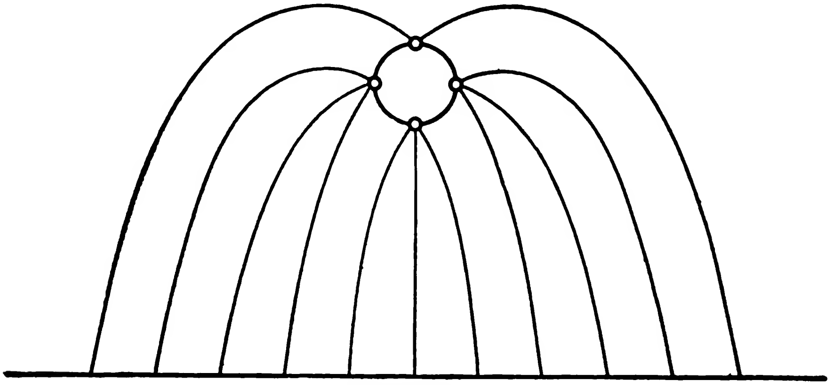


FIGURE 2

In the cage type of antenna, however, all the wires have practically an even chance, and each of them presents a much greater effective radiating surface than in the arrangement shown in the upper diagram.

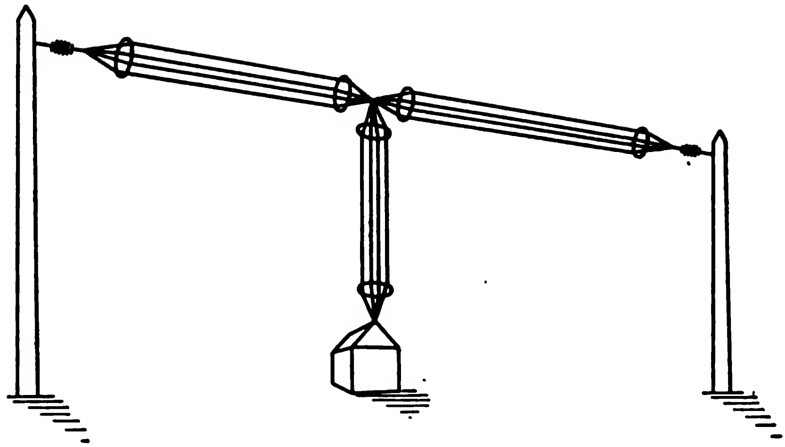


FIGURE 3

The cage antenna may be used as a T-type by building three small cages, using two of them as the horizontal part, with the third cage fastened between them and serving as the lead-in.

wire cage is to be built, six lengths are cut and stretched out along a flat piece of ground and one by one they are fastened and soldered to the supporting loops. These loops can be made of No. 00 hard copper wire bent into a circle one foot in diameter and soldered. There should be a loop at every 15-foot distance along the antenna. Thus for a 75-foot antenna, six loops will be required, including the additional loop at the end. Each loop should be marked with a file into six sections so that the wires can be attached and soldered in such a way that the position of each wire will be exact when the cage is hoisted into place

At the ends of the cage the six wires should be joined together and fastened to a long 22-inch insulator, to the other end of which is attached the supporting cable.

The cage antenna can be used as an inverted L type of antenna (see diagram on photograph), or as a T-type antenna. In the case of the inverted L-type, the lead-in is connected to the end of the cage; in the case of the T-type two smaller cages are used with the lead-in fastened between them as shown in Figure 3.

The lead-in may also be constructed in the form of a cage. The loops for the lead-in should be 8 inches in diameter, instead of one foot.

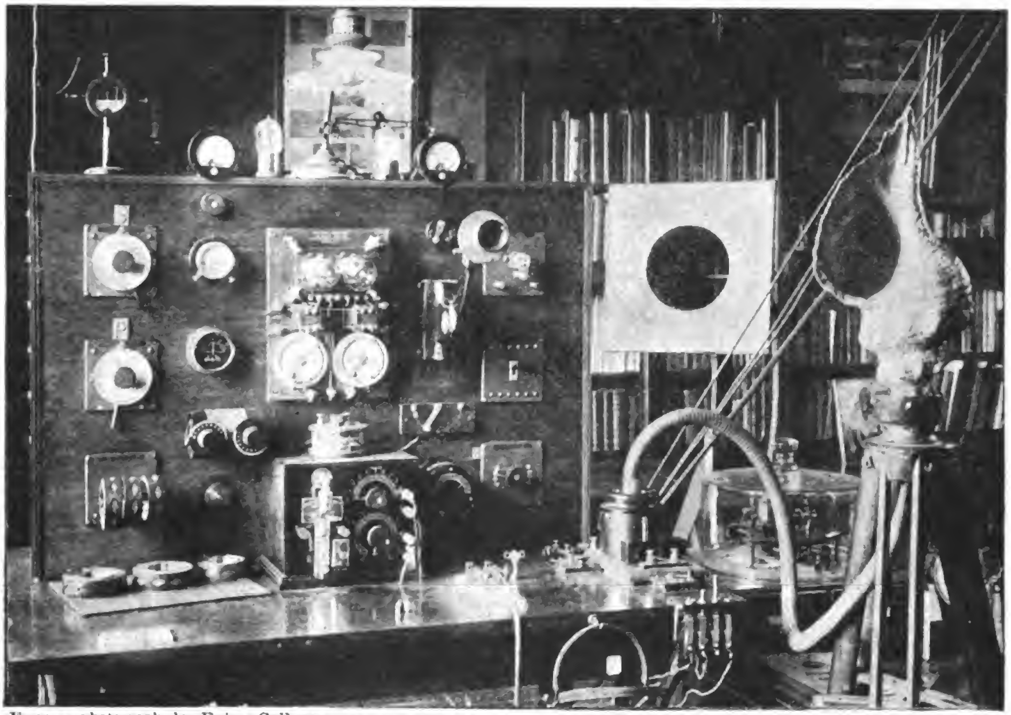
The Public Benefit of Good Broadcasting

To the Editor of Popular Radio:

"I heartily approve of your proposed plan to broadcast good music and valuable information from the great centers of New York and the country. I see no reason why this should not be done, especially as the expense of doing it is now relatively small and the public able to benefit by it is large."

Edward R. Hewitt

Treasurer, Cooper Union



From a photograph by Ewing Galloway

A "Loud Speaker" *from* a Conch Shell

A LOUD speaker made from a sea shell is a new and easily constructed device that amplifies the smallest details of broadcast music with a minimum of the echoes and harsh distortions made by metal amplifying horns.

The compartment of the human ear known as "the winding staircase" suggested the sea shell to the inventor, Father Frederick L. Odenbach. After experimenting he found that a triton or conch shell served the purpose best. So he sawed off the tip of the shell making a cross section of about an inch and a half in diameter. The opening in the sawed end of the shell was then widened out and the winding chamber inside was enlarged so that it was about the size of a finger. The shell was mounted on a block of wood to hold it solid, and a piece of ordinary garden hose was attached. The hose was extended to a sensitive telephone receiver or to one of the many commercial sound-amplifying devices which use a horn for a resonator.

The sea shell amplifier is reported to work well in a parlor, but for concert halls the inventor has perfected a pyramid horn of thin wood. The wooden horn is not quite as clear as the shell amplifier but it is more powerful. The pyramid horn was made two inches square at the small end and a foot square at the large end. Thin shellacked wood was used for all four sides, two opposite sides of pine and two of maple. The opposite sides were connected by thin splinters of wood, fitted into the interior of the horn.

Over the large end was placed a thin piece of wood with a round hole in the center, six inches in diameter. This was the ordinary wood used on the backs of framed pictures. The wooden pyramid was connected to some kind of electromagnetic amplifier, in the same manner as the sea shell was connected, with a length of rubber hose.

From a photograph made for POPULAR RADIO

AN UNUSUAL COLLECTION OF AMERICAN AND FOREIGN TUBES—*The various forms of vacuum tubes shown above may be identified as follows: 1, the Myers audion (American); 2, amplifier tube used by the French; 3, the De Forest rectifier tube (American); 4 and 5, German tubes made during the war (on account of the scarcity of brass in that country at the time, the bases of these tubes were made of iron); 6, the well-known Moorhead Electron-relay (American); 7, the original* ***De Forest "Audion" (American).***

How *the* Vacuum Tube Detects

SIMPLE "HOW" ARTICLES FOR THE BEGINNER—NO. 7

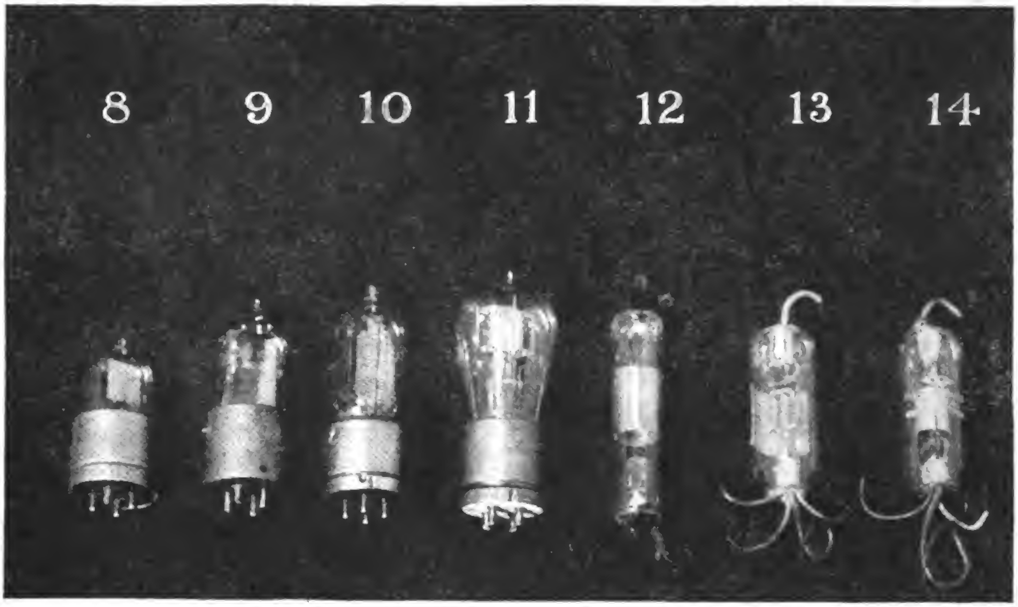
By LAURENCE M. COCKADAY, R.E.

IN the preceding article on the crystal detector we learned that radio frequency currents must be "rectified" or reduced to a pulsating direct current before they can be used to produce sound waves in the telephones. The crystal detector does this on account of its inherent "unidirectional conductivity." By unidirectional conductivity is meant the ability of the crystal to pass currents through itself in one direction, while preventing currents from flowing through itself from the opposite direction.

Thus, if a crystal be connected in an alternating current circuit, only half the impulses will flow through it and the other half of the impulses (trying to flow in the other direction) will be resisted, or held back. A crystal, then, conducts currents much better in one direction than in the other, and the current that actuates the telephones in a crystal set is that current (which happens to be flowing in the right direction) which the crystal lets through. It will readily be seen that this actuating current is but a part of the received energy, and if all the incoming current could be put to work in some way or other, much louder signals would be produced in the telephones.

We shall now see how the vacuum tube uses all of these received impulses, both positive and negative, and uses them so as to act as a trigger acts in a gun. It

*See "How the Crystal Detector Detects," in POPULAR RADIO for October, 1922.



—INCLUDING SOME OF THE EARLY MODELS USED BY AMATEURS

8 is the De Forest VT-21, a wartime tube (American); 9, the Moorhead amplifier tube (American); 10, the Western Electric VT-1, used by the U. S. Navy and the U. S. Signal Corps during the war (American); 11, the Radiotron, now in common use for detection and amplification (American); 12, the tubular "Audiotron," at one time the amateur's favorite detector (American); 13, an amplifier tube with a second spiral grid that serves as a plate (Japanese); 14, a detector tube, evidently copied after the "Audiotron" (Japanese).

takes but a small effort to pull the trigger, although the resultant explosion is many times more powerful than the trigger effort. So the vacuum tube uses the feeble received currents to "trigger off" larger currents supplied by the "B" battery and in this way at the same time amplifying or strengthening the signals. In this case the "B" battery may be likened to the powder in the gun, and the feeble incoming impulses may be likened to the pressure upon the trigger. An incoming impulse pulls the trigger of the vacuum tube, so to speak, and the "B" battery connected in the plate circuit of the tube immediately "shoots" the energy to reproduce the trigger impulse in much amplified fashion. This is made possible by the rectifying and amplifying qualities of the vacuum tube itself, giving receiving results far superior to those of the crystal detector which possesses only the quality of rectifying.

Edison, while studying the effects of heated filaments of carbon in the old-fashioned electric incandescent lamp, found out that the filament got thinner and thinner as the lamp burned, and that the glass bulb began to get darker and darker at the same time. The filament seemed to be disintegrating, and giving off particles which shot across the evacuated space and stuck to the glass. He conceived the idea of placing another electrode or wire in the lamp that would collect these little particles which constantly were being driven away from the filament. Later he found that the extra wire became charged slightly negative every time the lamp was turned on, and finally a battery was connected across between the wire and the filament, with the positive terminal of the battery connected to the wire. Immediately a current was detected flowing in this circuit, and when the lamp was turned off, the current promptly stopped. This action was called the "Edison effect," and we know

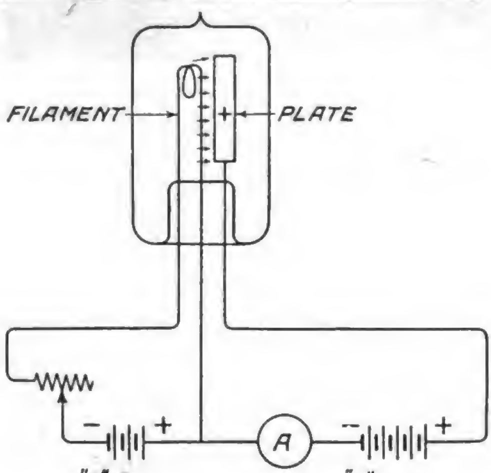


FIGURE 1

A model of the first vacuum tube, made by J. A. Fleming in England; it contains only the filament and the plate. The diagram illustrates its unilateral conductivity.

now that all filaments when heated in a vacuum give off electrons which fly off and away from the filament.

Fleming made use of the Edison effect when he designed his valve which consisted of a filament and a metal plate in a vacuum tube. In Figure 1 is shown a diagram of a Fleming valve connected to an "A" battery for heating the filament and a "B" battery for keeping the plate positive to help attract the negative electrons. When the tube is connected up (as shown in the diagram) with a current-measuring device, A, connected in series with the "B" battery, and the "A" battery current is turned on (thus heating the filament), a current is immediately indicated by A, flowing in the plate circuit. If the "B" battery is reversed so that the plate is negative, no current is measured by A, showing that the tube will pass current from the plate to the filament, but not from the filament to the plate. This of course is true only while the filament is heated and giving off electrons—the electrons really constituting the plate current, although we consider the current as flowing in the opposite direction to the electrons.

Before we go any further, there are three points to remember which are important if we are to understand the action taking place in the vacuum tube:

First: a vacuum tube will pass current only from the plate to the filament.

Second: the strength of this current is dependent upon the density of the stream of electrons passing from the filament to the plate.

Third: the density of the stream of electrons is dependent upon the temperature of the filament, the kind of material the filament is made of, the distance between the filament and the plate, and the amount of "B" battery potential applied to the plate.

While experimenting with electron streams in flames and hot gases, De Forest found that he could control the strength or density of the stream of electrons by placing a charged wire mesh in the path of the stream. That this is a fact will at once be evident to anyone who knows that "like charges repel, and unlike charges attract." The electrons are negative, and when the mesh is charged negatively the electrons in the stream which are trying to pass through the holes in the mesh are repelled and the stream is reduced and stops, and when the mesh is charged positively, the electrons are strongly attracted and the stream is increased and strengthened.

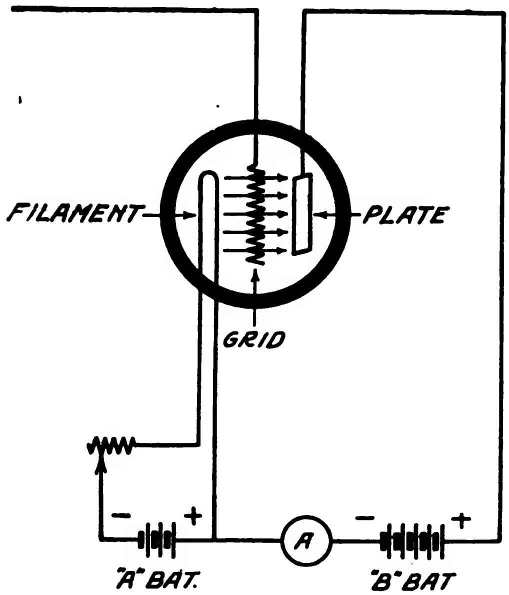


FIGURE 2
Diagram of the insulated grid in the vacuum tube.

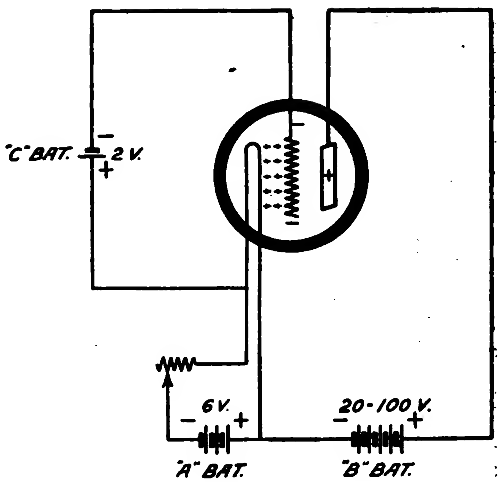


FIGURE 3
This diagram illustrates the action of the negative charge on the grid.

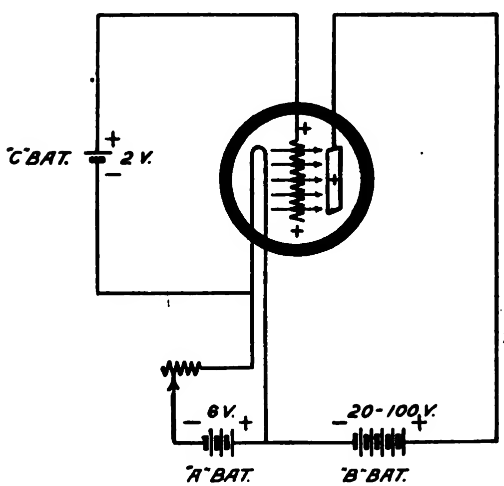


FIGURE 4
The action of the positive charge on the grid. Compare this with the diagrams above.

De Forest then applied this principle to the vacuum valve and interposed his famous "grid" in between the filament and the plate. (See Figure 2.) In this diagram the grid is shown disconnected and has no externally applied charge on it. In this state the tube would act about the same as the Fleming valve; that is, there would be a flow of electrons across from the filament to the plate if the filament is heated. This is the same as stating that a current would flow from the plate to the filament (refer to the three points to be remembered, mentioned above). The electrons would pass through the spaces in the grid.

Now suppose we should connect a small battery "C" across from the filament to the grid with the negative terminal connected to the grid and the positive terminal connected to the filament, as shown in Figure 3. This would make the grid negative with respect to the filament, or in other words a negative charge of 2 volts will be placed on the grid. Let us study the effect of this charge on the grid in the diagram. The electrons trying to leave the filament, represented by the arrows, are negative. The grid is charged negatively, by the "C" battery. Remembering the fact that "like charges repel and unlike charges attract," we readily see that the electrons are repelled and forced back to the filament; a small number, or none, ever get across to the plate. Hence, in this condition the tube lets little or no current across from the plate to the filament.

What would happen if we suddenly were to reverse the terminals of the "C" battery which is charging the grid? Let

us investigate in Figure 4. In this case the grid would have a positive charge of 2 volts, and the negative electrons would be strongly attracted across from the filament to the grid. When they get this far on their journey they begin to feel the greater attraction of the higher positive voltage charge on the plate and they pass through the spaces in the grid in a flying effort to get to the plate, which receives them "with open arms," so to speak. The attraction of the positive charge on the grid draws many times more electrons from the filament than would ordinarily leave it, and thus the density of the stream is increased many times. Another reference to our famous three points will prove that there is at this time a much stronger current flowing from the plate to the filament. The current flowing across from the plate to the filament of course is a direct current, and is known as the "plate current" of the tube. To sum up the action of the tube in a few words, we might say that "the plate current (explosion) of the vacuum tube can be controlled by the voltages (trigger) applied to the grid."

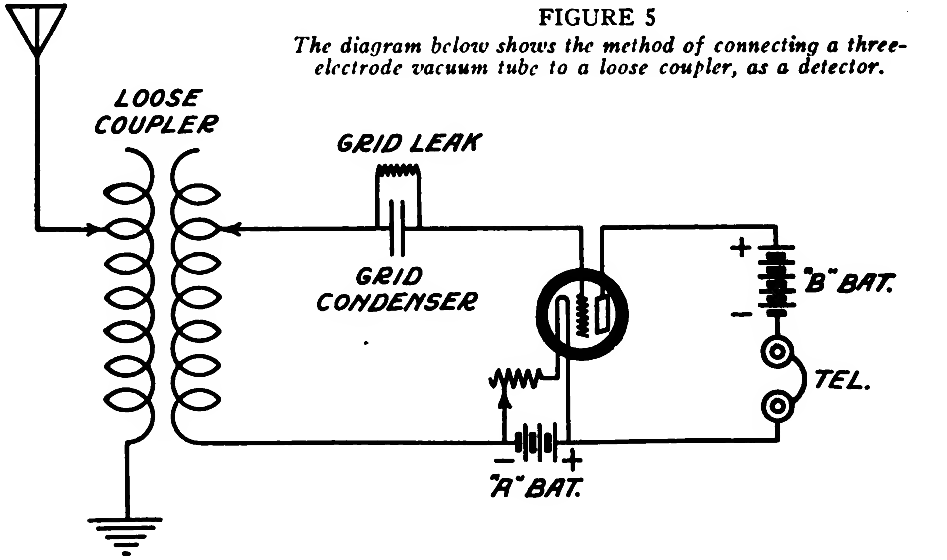
Now we can see the likeness between the action of the vacuum tube and the action taking place in firing a gun.

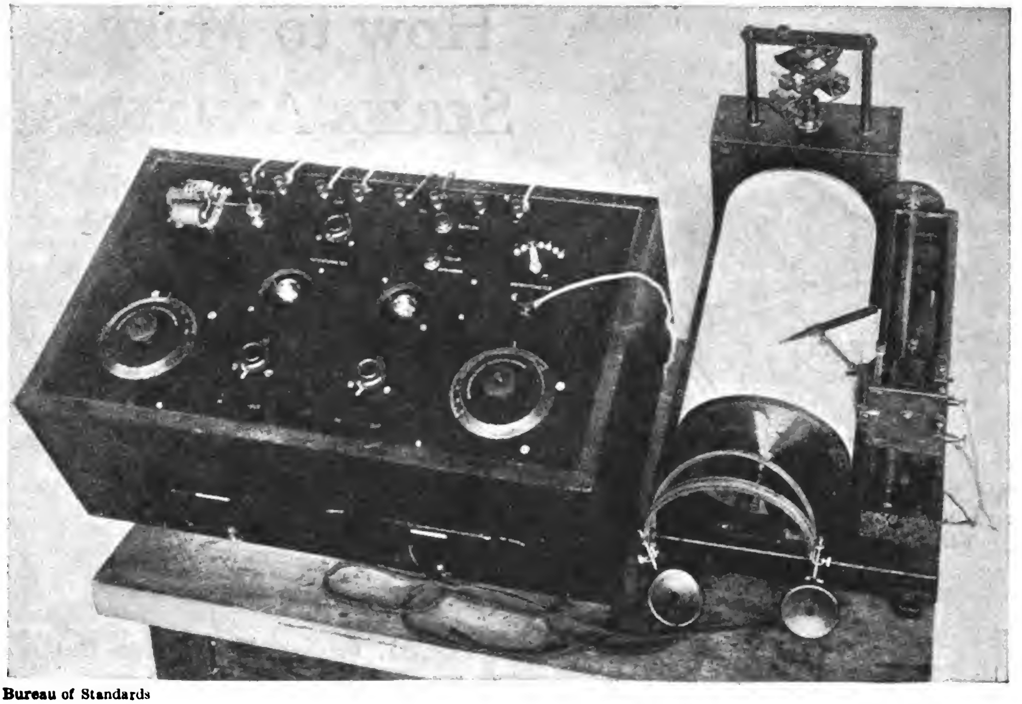
It takes a very small change in grid voltage to effect large changes in the values of plate current, and it is this plate current that is used to actuate the telephones in a vacuum tube receiving circuit. The feeble received impulses are used to "trigger off" much larger currents supplied by the "B" battery, in this way at the same time amplifying and strengthening the incoming signals. This is the reason why the vacuum tube gives so much stronger signals than the crystal detector, which only rectifies the weak incoming impulses.

In Figure 5 is shown a conventional circuit with a vacuum tube used as a detector. The loose coupler is used to tune in to the desired wavelength, so that the radiated energy may be received and applied to the grid in the form of high frequency impulses. These impulses vary the amount of the direct plate current of the tube so that the same voice waves as spoken into a distant telephone transmitter are reproduced and amplified in the telephones which are connected in series with the plate and "B" batteries. A grid condenser is used to supply the incoming charges to the grid of the tube. The grid leak resistance is used to prevent the negative charges accumulating on the grid in such large quantities that the tube becomes inoperable.

FIGURE 5

The diagram below shows the method of connecting a three-electrode vacuum tube to a loose coupler, as a detector.





Bureau of Standards

With the aid of an ordinary fountain pen, this novel radio set makes a written record of code signals that come in during the operator's absence.

A Receiving Set that Takes Down Notes

IF you are an operator, amateur or professional, who fears that some message of value may come in by radio while you are away from your receiving set, you need carry your anxiety no longer. You may merely employ a mechanical understudy that will automatically take down the signals—and take them down in writing—while you are absent.

This novel device has been built by Dr. E. A. Eckhardt and Dr. J. C. Karcher of the Bureau of Standards in Washington. It copies down the dots and dashes sent from a distant transmitting station without any supervision whatever from a radio operator, and the permanent record made by this machine may be deciphered at leisure by anybody who possesses a copy of the code chart. The dots and dashes are recorded as short and long humps along a continuous spiral inked line made by an ordinary fountain pen around a slowly revolving cylinder—shown on the right of the illustration.

A feature of the device is the fact that it functions without the use of amplifiers, yet at the same time it is possessed of great sensitivity, copying messages from as far away as Lyons, France—a distance of 3,800 miles.

The actuating mechanism for moving the pen back and forth and sidewise while the cylinder revolves (thus recording the received impulses), consists of an extremely sensitive electromagnet.

The device was built for the specific use of the Coast and Geodetic Survey of the United States Department of Commerce, and at present is being used for recording time signals on surveying expeditions in remote sections of the country.

It is conceivable that from this device may be developed a machine for long-distance writing by radio—even to the signing of checks.

How to Make a SERIES-ANTENNA CONDENSER

Do you want to increase the flexibility of tuning in your set—especially on the lower wavelength ranges? This article tells how to make the necessary condenser for 50 cents.

BY WATSON DAVIS

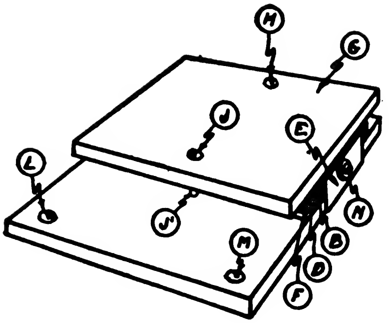


FIGURE 1A

This drawing shows the condenser completely assembled. The parts designated by letters are described in the accompanying text.

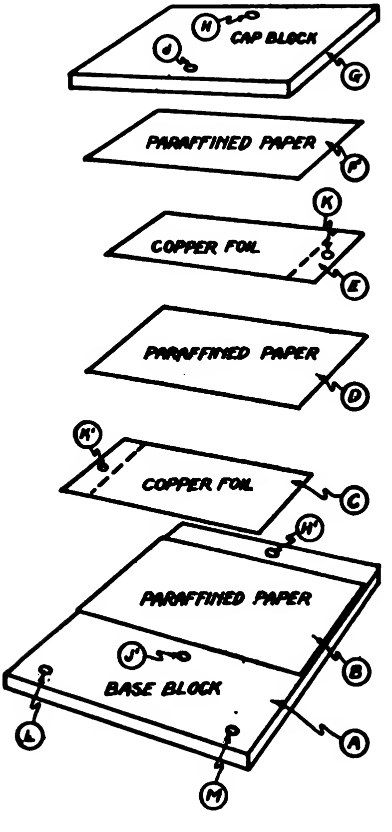


FIGURE 1B

This diagram shows the component parts of the condenser in the correct order of assembly reading from the bottom upward. The different parts are prepared as indicated in this article.

THOSE readers of POPULAR RADIO who have built the radio receiving sets that have been developed by the Bureau of Standards in Washington and described in specific detail in this magazine* may now improve their apparatus by adding a condenser in the antenna circuit. The fact that this addition may be made at home for the modest sum of about half a dollar commends it to the radio fan to whom the cost is a factor as well as to the fan who finds delight in building his equipment with his own hands.

The effect of the series-antenna condenser in a receiving set is to enable the receiving equipment to give signals of somewhat greater intensity when tuned to wavelengths of 300 meters or less. It will thus be seen that the effect of this condenser is just the opposite of the effect obtained by a greater number of turns of wire on a tuning coil, which, it will be remembered, permits the receiving equipment to respond to longer wavelengths.

The series-antenna condenser described here has a rated capacity of about 0.0003

*See "How to Make and Install Your Own Receiving Set" in May, 1922; "How to Make and Operate a Two-Circuit Receiving Set" in July, 1922, and "How to Add a Vacuum Tube to Your Crystal Receiving Set" in November, 1922.

microfarad (300 micromicrofarads). This is how to build it:

How to Make the Condenser

The condenser is shown in detail in Figures IA and IB. Two thin strips of metal, C and E, 1 inch wide and 3 inches long, are used with three sheets of insulating material, B, D and F, 1½ inches wide by 3 inches long. The metal strips may be thin copper, brass or aluminum. Each of the three sheets of insulating material is made up of two pieces of heavy white writing paper which are separately dipped in clean, melted paraffin. Each pair of sheets is then pressed together by means of a warm iron; when cold the strip is cut out to the required size. A sheet of clear mica, of about the same thickness as the two sheets of writing paper mentioned above may also be used for the insulating material. Two blocks, of hard wood (G is 2⅝ by 3½ inches, A is 3 by 3½ by ½ inches) are cut out. Two screws pass through holes H and J in the upper block G, which is placed over the block A, so that the edges of the two blocks are even on three sides. (See Figure 1A.) The holes for the screws H and J are ⅜ inch from the sides of the block G and equally distant from the ends.

Having located the correct position of the block G, the screws in holes H and J are loosened and the block is removed from A, leaving two small holes H^1 and J^1 to locate the proper position of the blocks when the condenser is finally assembled. The two screws L and M are located just far enough in from the front edge (see A Figures 1A and IB) so that the block A may be screwed to the left end of the baseboard of the receiving set. (See Figures 2 and 3).

The wooden blocks are of dry wood smoothed up with sandpaper and given a coat or two of varnish which will not absorb moisture, or treated with paraffin.

A sheet of the paraffined paper (or mica) B is placed on the block A between the holes H^1 and J^1 so that its ends are even with ends of the block. A thin metal strip, C, is placed in position so that it lies in the center of B and has its right end ½ inch in from the edge of the base block and its left end projecting ½ inch over the opposite edge of the base block. (See Figure 1B.)

Another sheet of paraffined paper D is placed on C directly above B. The second piece of thin metal E is placed on D and above C, except that one end of the metal strip E extends ½ inch over the ***right*** edge of block A instead of the left, as did C. The third sheet of paraffined paper F is placed on E directly above D and B.

The alternate sheets of paraffined paper and thin metal are held carefully in position, and the block G is placed over them and screwed in position. The right end of the thin metal strip E is bent down, and a round-head brass screw N is passed through a hole K punched or drilled in the end of the metal strip. The projecting end of the strip C is not visible in the Figure IA, but it is bent and fastened

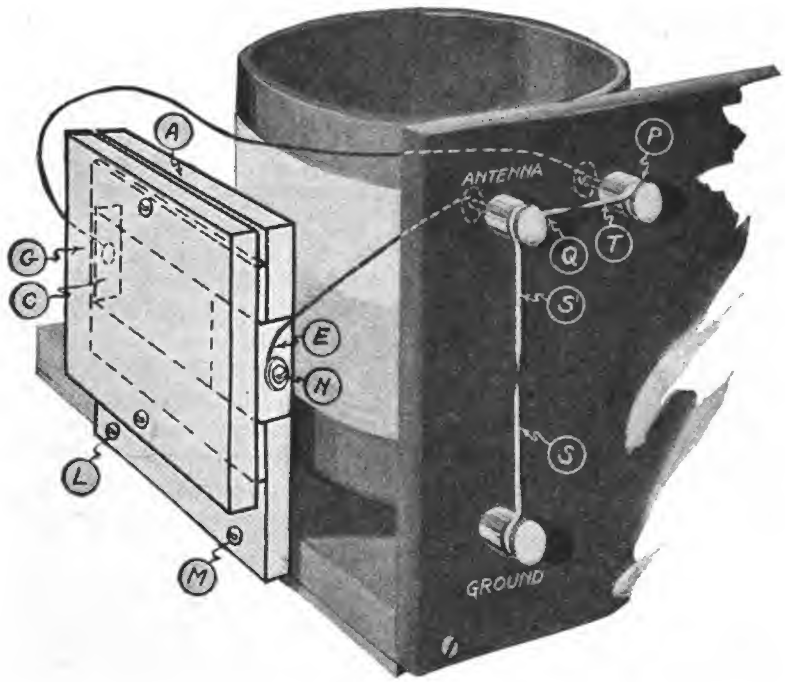


FIGURE 2
How the condenser is used in combination with the single circuit receiver.

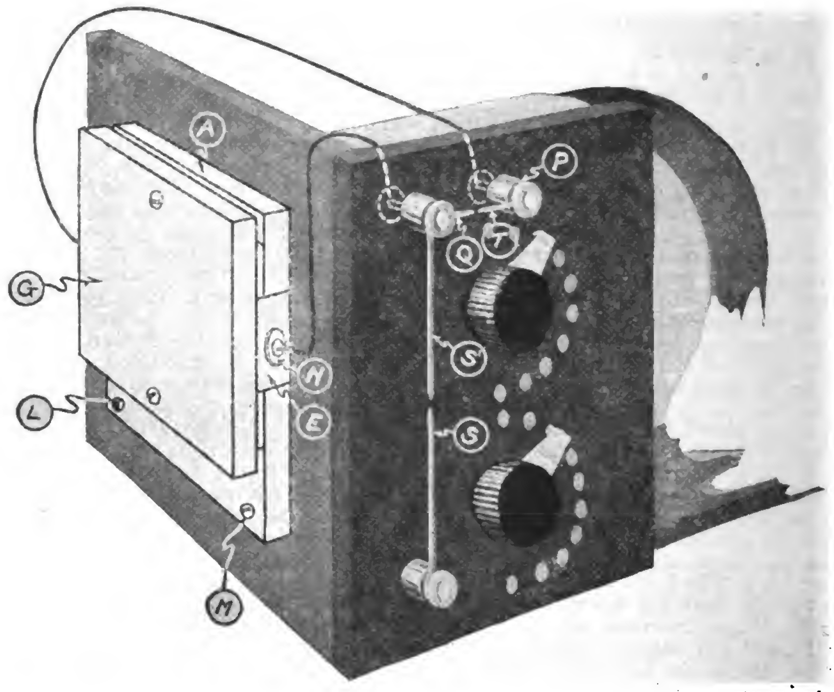


FIGURE 3

This drawing shows how the antenna condenser should be connected to the double circuit receiver.

in the same manner as E. The completed condenser resembles the sketch shown in Figure IA.

How to Mount and Wire the Condenser

The condenser is mounted on either the single-circuit receiving set described in the May issue of *Popular Radio* or the two-circuit receiving set described in the July issue. Figure 2 shows the method of mounting the condenser on the single-circuit receiving set. The condenser is fastened to the end of the baseboard by means of the screws L and M. A binding-post P is added to the panel of the receiving set about 1 inch from the binding-post marked "Antenna," as shown in Figure 2. A wire is clamped under the condenser screw N which passes through the metal strip E, forming one terminal of the condenser. This wire is led to and connected to the back of the binding-post marked "Antenna" without disturbing any of the other wires which are already connected to this binding-post. Another wire is connected to the terminal of the metal sheet C and led to the back of the binding-post P.

In the diagram in the May issue a short stiff wire is shown attached to the "Antenna" binding post and extending toward a similar wire attached to the "Ground" binding-post. The wire on the "Antenna" binding-post is removed and a longer one substituted so as to form parts Q and S; Figure 2. A similar short piece of stiff copper wire T is attached between the first and second nuts of binding-post P. There is a very short gap between wires Q and T and between S′ and S. These gaps are for protective purposes when one forgets to throw the lightning switch to the grounded side. Another method of protection would be to install a lightning arrester in the antenna system. The arrester may be installed just outside or just inside of the building, preferably the former. This serves as an extra precaution when one forgets to throw the lightning switch to the ground terminal when the receiving set is not being used.

If the condenser is mounted on the receiving set described in the July issue, it may be placed as shown in Figure 3. In other words, it is mounted upon the vertical board which supports the primary coil tube previously described. The connections from the condenser to the binding post on the front panel of the two-circuit set are made as described above.

If the connections to the receiving set have been made as described, the antenna lead-in wire is removed from the binding-post marked "Antenna" and connected to the new binding-post which has been added to the front panel of the receiving set. (See P, Figures 2 and 3). The condenser is now included in the electrical circuit together with the tuning coil, between the antenna and ground. This connection to the binding-post is used when it is desired to receive wavelengths of 300 meters or below. To receive wavelengths of 300 meters or more,

the antenna lead-in will ordinarily be connected to the binding-post marked "Antenna" and the operation of the receiving set is then as described in the previous articles. The switches are set so as to include more turns of wire on the tuning coil (or the primary coil of the two-circuit receiving set) with the antenna lead-in connected to F than when it is connected to the binding-post marked "Antenna," when tuning to a given wave frequency.

This will provide greater coupling, resulting in greater energy transfer from the primary to the secondary, and hence louder signals.

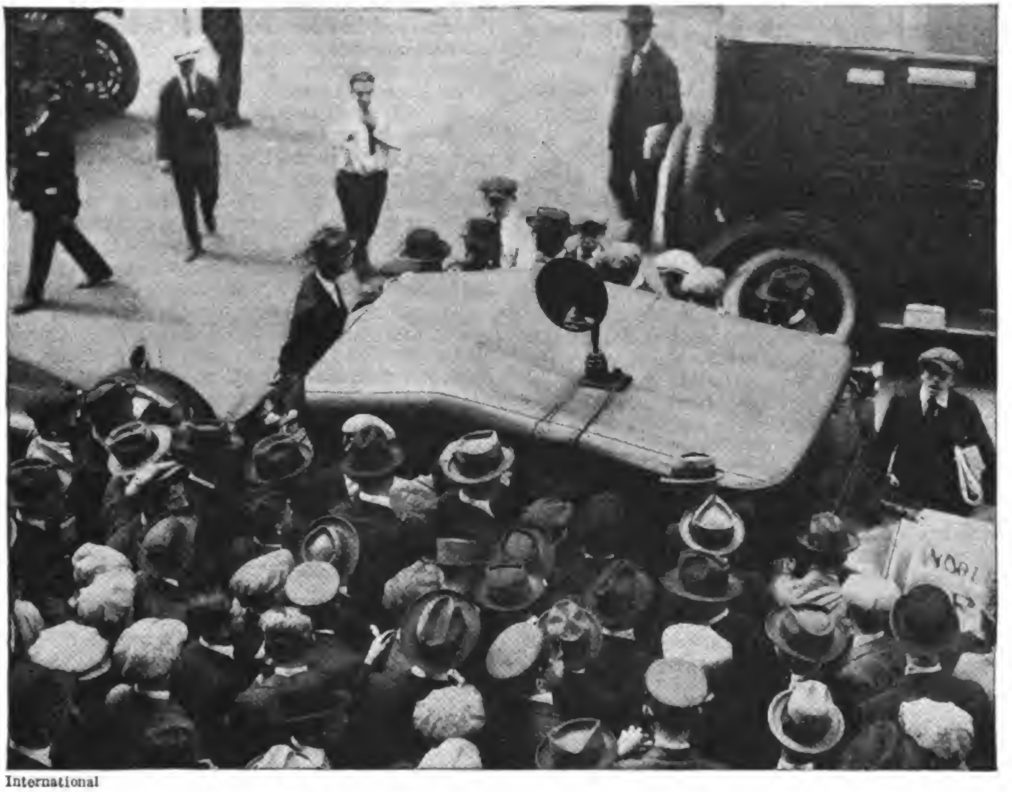
What It Will Cost

The material required and the costs of the various items are listed as follows:

2 metal strips (copper, brass or aluminum)........................	$0.10
3 sheets of mica (if used)............	.20
1 binding-post (any type)............	.10
6 wood-screws........................	.10
2 small wooden blocks................	
Paraffin	
Paper	
Total cost...........................	$0.50

Photographing Our Emotions—by Radio!

¶ How highly sensitive radio apparatus is now being used in the realms of medicine for recording the physical and nervous conditions of patients; how this same apparatus is even making graphic records of the reactions of our thoughts—will be told in the January issue of POPULAR RADIO by Dr. Henry Smith Williams.



International

RADIO BRINGS BASEBALL TO THE CURB

Some intimation of the possibilities of radio for adding to the sum of human happiness was demonstrated over a wide area during the World-Series baseball games in New York, when sideline reports of each play were broadcast from WJZ—thanks to the timely cooperation of the Western Union in furnishing wires. One enterprising radio amateur installed a receiver on his motor car and demoralized the financial center of the world for a few hours when he established himself on Wall Street and permitted millionaires and office boys to follow the score.


LISTENING IN

HELP *your neighbor. If you have discovered any little Kink that helps to eliminate trouble in your radio apparatus, or if while experimenting with the connections of your set you should run across some interesting phenomenon, or if you should discover some new hook-up that gives better results—send it to the "Listening In" page.*

How to Combine Your Crystal and Your Vacuum Tube

ONE reader finds that he can use a crystal and vacuum tube at the same time with a saving of life of both the tube and batteries and at the same time increase the strength of signals over and above the strength that a crystal will ordinarily produce. He uses a circuit similar to that on page 222 of the July issue of POPULAR RADIO. He writes:

I have my crystal detector connected across my vacuum tube circuit; that is, from the top side of my loose coupler to the negative terminal of my "B" battery. This enables me to hear signals through my crystal detector. Then I turn on the tube, with the crystal still connected, and find that the signals increase in sound to a point nearly equal to that of the tube when it is used by itself with about half the current it takes to bring in the signals on the tube. I have the wire connecting the crystal to the negative "B" battery loosely connected and by lifting it away and thus disconnecting the crystal, the signals disappear. This proves that by the use of both detectors the signals can be increased with half the power from the battery, which saves the charge in the battery and at the same time lengthens the life of the tube, as it does not have to burn so brightly. Test this out to your own satisfaction and see what you think about it.

W. J. THOMPSON

* * *

The High Cost of Radio in Germany

THE radio fan abroad is not blessed with the advantages of his Yankee *confrère*. The handicaps under which Hans struggles in Germany, for instance, is briefly outlined by Vice-Consul Nathaniel B. Davis in Berlin:

German manufacturers of radio apparatus and equipment are not in a position to make extensive deliveries of their product. This is due to the fact that up to the present time the demand has not been sufficiently great to warrant the manufacture of radio instruments in large quantities.

Amateur radio work is not popular in Germany and stations are not numerous. Radio telephony in particular is almost an unknown science except to engineers, professional operators, and experimenters. The principal reasons given for the lack of interest in radio on the part of the general public are that amateur stations are a luxury beyond the means of the average German, under present economic conditions, and official restrictions on their use.

All radio communication in Germany is under the control of the Federal Post Office Department, which operates the commercial stations. Private installations must ordinarily be made by the Department; in exceptional cases private companies or individuals may be authorized to erect their own plants, but they must first obtain a license from the Post Office Department. The fee for such a license varies according to the size of the plant, with a maximum of 2,000 marks a year.

At present only one station in Berlin is licensed to broadcast. This station broadcasts market and exchange quotations. Subscribers to its service are permitted to install receiving stations upon payment of the license fee and the monthly subscription rates, which vary at present from 1,000 marks to 7,500 marks, according to the class of subscription. Subscribers may rent receiving sets from the Post Office Department for 2,500 marks a month if they do not desire to build their own.

In spite of the lack of demand for short-wave amateur apparatus there are a number of firms in and about Berlin which manufacture either complete receiving sets or parts. Vacuum tubes are almost unavailable, and practically all receiving sets manufactured in the Berlin district operate with crystal detectors.

Blocking Bandits with Radio

THE use of radio for running down law-breakers is not new. But a novel and dramatic use of it is being found, for it is thwarting the bandits of Mexico; here is a description from a former official of the American Chamber of Commerce in Tampico:

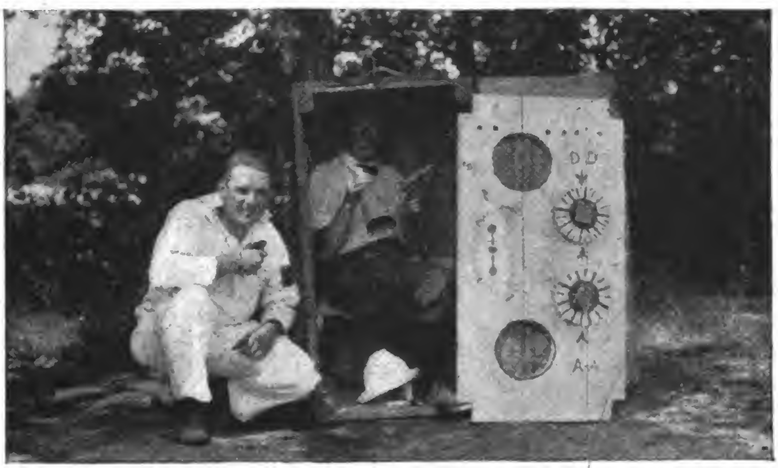
It took robbery and violent death at last to bring radio into the Tampico oil fields as the new hope of the oil companies, and the *rurales* who are supposed to preserve law and order. The recent killing of one American, the wounding of two others and the taking of 42,000 pesos from a paymaster for the Companias del Agwi finally decided that organization to apply to the Mexican Government for a permit to install radio receiving and sending apparatus, for connecting its headquarters in Tampico with its sea loading stations and camps in the lower field, in the State of Vera Cruz.

Robberies have been of almost weekly occurrence in the great Tampico field, which takes in hundreds of square miles of jungle in which, heretofore, the bandits have found it easy to outwit the *rurales*. A gang of bandits that was recently broken up was armed with portable telephones and had been listening in on the private lines of companies; there is little doubt that the arrangements for the transportation of the payroll stolen from the Agwi company were discovered by the bandits in that manner. The company had arranged to send the money over the most dangerous part of the trip by airplane, believing it could evade bandits in that way, but the bandits evidently had learned all the details of the plan, and held up the paymaster before he reached the place where he was to have taken the airplane.

The Mexican Government has a monopoly on all telegraph and telephone communications, however, and it is only by special permit that any private company can transmit or receive messages. The great oil companies have such permits and all the principal companies have private telephone lines—the only long-distance telephone lines in Mexico. All radio outfits which cross the border, therefore, must be reported to the Mexican Government, and it is believed that the government can easily keep tab on all such equipment in territory under its control, so that it will be virtually impossible for bandits to listen in on the oil companies by radio. At present, the bandits know nothing of radio.

The experiment the Companias del Agwi is about to make will be watched with great interest by about thirty other oil companies, and it is probable that soon radio will have secured a start in Mexico from which there will spread rapidly, enlightenment and progress throughout the entire Republic.

LEE SHIPPEY



A STATIC-PROOF RADIO SET

When two hundred members of the American Canoe Association recently gathered at Sugar Island, near Gananoque, Canada, for an evening's entertainment, they were treated to a truly remarkable exhibition of the possibilities of radio. A huge (and obviously home-made) receiving set was carried out before the audience, an aerial was solemnly run up on a flag-pole and a serious radio lecture was delivered by the "operator," Oscar S. Tyson. Inside of the set was concealed George P. Douglas, who with the help of a phonograph for music, a megaphone for speaking, two flashlights for tubes and several "rattlers" and "squeakers" for static gave a very creditable bit of broadcasting which entirely fooled the audience—until the front plate of the set was removed at the end of the entertainment.

Radio on Life-Boats

EVEN the life-saving boats of the romantic Coast Guard service are becoming modernized—by the installation of radio sending and receiving apparatus. (Glance at the cover design on this magazine.) Some months ago the Bureau of Standards conducted some tests of this equipment off Atlantic City; new experiments are now being carried on at the Curtis Bay Station, south of Baltimore. Only the expense of the apparatus has prevented earlier installations. How the problem is being worked out is told by an expert as follows:

The one great hindrance to the work of life-saving corps has been in maintaining communication. In pre-radio days the only methods of communication between a foundering ship and vessels were the use of rockets and the shooting off of bombs, and even these were of limited value as they served only as a means for determining the approximate position of the vessel in distress, and could give no details of the trouble.

Radio, as supplied to the vessels themselves, has offered a partial solution to this problem; the application of radio to the life-boat itself has been a more difficult problem to solve, largely because an antenna mast and antenna on a life-boat, even though of the sturdiest construction, could last only a few moments in a heavy sea. Further, when a life-boat approaches a ship's side, the aerials would undoubtedly be carried away when the boat rolled over against the vessel. To overcome this difficulty a new type of antenna has been developed which does not require masts; it is virtually a loop antenna, and is the outcome of a considerable amount of experimental work in connection with the installation of radio on submarines.

A heavily insulated wire is run from the bow of the life-boat down along one side of the keel, extending back to the stern, up the stern, and then back to the bow on the same side of the boat along the scuppers. The same wire is then led in the same path, fore and aft, on the other side of the boat, so that it forms a two-turn loop. The two terminals are led to the radio telephone installation which is located under the canvas spray-hood. This form of antenna can be used for both transmitting and reception over the normal cruising range encountered. The equipment used is of the Western Electric type that was employed during the war on submarines and sub-chasers. The transmitting and receiving apparatus used at the Coast Guard land station is also of the Western Electric type.

By the use of this new equipment, the life-saving boat may be at all times in two-way communication, not only with the land base, but with the vessel in danger, and with other ships standing by.

D. C. SANDERS

THE MODERN SUCCESSOR TO THE ROCKET

Conversation by radio between shipwrecked mariners and their rescuers may lack the dramatic touch furnished by fireworks-signals. But it will save more lives.

Side-line Reports by Radio

ONLY the inability of the broadcasting stations to obtain the necessary telephone wires for transmitting side-line reports of the big football games this fall prevented the radio fans from listening in on any considerable number of these picturesque events. One university is apparently going to do its own broadcasting in its own way, as this note from New Haven will attest:

The authorities at Yale University announce that in the future athletic events will be broadcast by radio to the surrounding cities. This means that anyone within a distance of about fifty miles of New Haven will be able to receive by radio play-by-play reports of the football, hockey, lacrosse and other games.

WHAT READERS ASK

THIS *department is conducted for the benefit of our readers who want expert help in unravelling the innumerable kinks that puzzle the amateur who installs and operates his own radio apparatus. If the mechanism of your equipment bothers you—if you believe that you are not getting the best results from it—ask* THE TECHNICAL EDITOR.

THE flood of inquiries that has poured in upon the Technical Editor has not only furnished evidence of the need of this department: it has also necessitated a system of handling the correspondence that will insure the selection of and answer to only those questions that are of the widest application and that are, consequently, of the greatest value to the greatest number of our readers. Our correspondents are, accordingly, asked to cooperate with us by observing the following requests:

1. Confine each letter of inquiry to one specific subject.
2. Enclose a stamped and self-addressed envelope with your inquiry.
3. Do *not* ask how far your radio set should receive. To answer this inquiry properly involves a far more intimate knowledge of conditions than it is possible to incorporate in your letter.

The questions that are not of sufficient general interest to warrant publication in this department will be answered personally. Many of these questions are being answered by referring the correspondents to items that have already been printed in these pages. To get the full benefit of this service, therefore, *save your copies of* POPULAR RADIO.

QUESTION: Please give me a hook-up for a tuning coil, a crystal detector, a variable condenser and a honeycomb coil.

T. P. D.

ANSWER: A circuit that uses the instruments you have on hand is illustrated in Figure 1. You will not need the honeycomb coil, but you will get better results if you obtain a fixed telephone condenser and hook it across the telephones as shown in the diagram. This condenser will serve to shunt the radio frequency currents *around* the telephone, allowing only the audio frequency currents to pass *through* them.

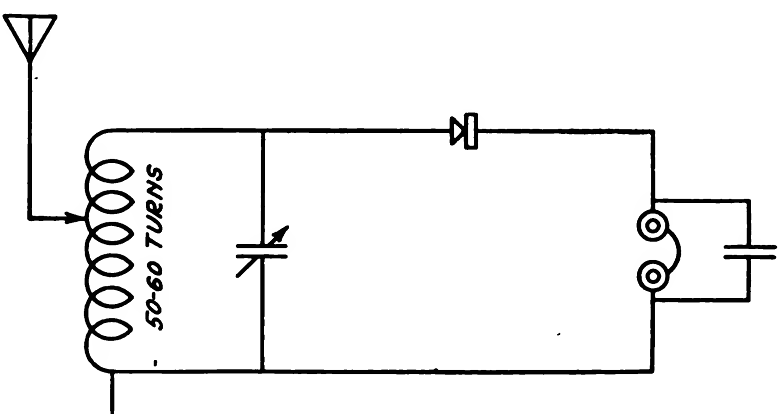


FIGURE 1
A crystal detector circuit that employs a single slide tuning coil and a variable condenser for tuning.

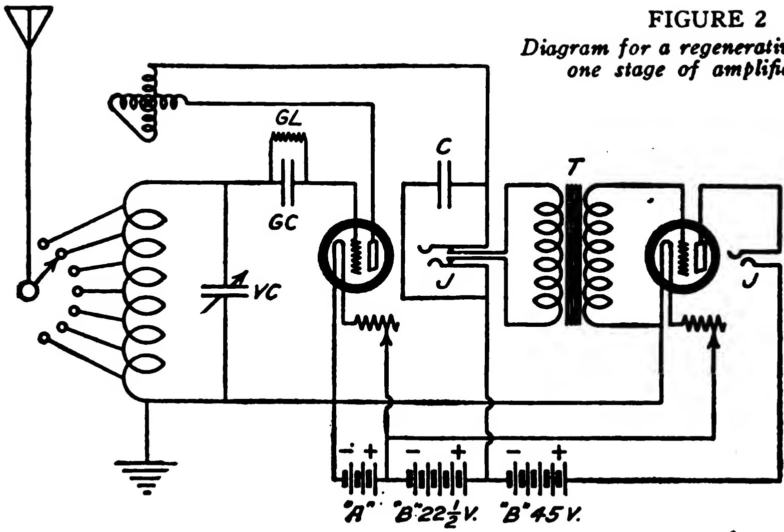


FIGURE 2
Diagram for a regenerative set with one stage of amplification.

QUESTION: Please give me a hook-up for this set: a 43-plate variable condenser, an inductance coil (10 taps), a variometer, an Acme amplifying transformer, two rheostats, two sockets, a Cunningham detector tube, a Radiotron amplifier tube, three "B" batteries, a grid leak and condenser, and an "A" battery.

WILLIAM ENGLE

ANSWER: See the diagram in Figure 2. The antenna tuning is accomplished by means of the taps, the secondary circuit is tuned by the variable condenser VC, and the plate circuit is tuned with the variometer. The first jack is a double circuit jack and the second is a single circuit jack. This circuit will be found to be selective and easy to tune.

QUESTION: Will you give me a hook-up using the two-slide loose coupler, as described in the July issue of POPULAR RADIO? This circuit should also include one fixed condenser, one variable condenser, crystal detector and phones.

RAYMOND LANGLEY

ANSWER: This is shown in Figure 3.

* * *

QUESTION: How can I cut out static on a regenerative set?

JAMES GOOCH

ANSWER: We know of no method of cutting out static entirely. It may be materially reduced by the addition of a single stage of radio frequency amplification to be attached immediately before your present regenerative circuit.

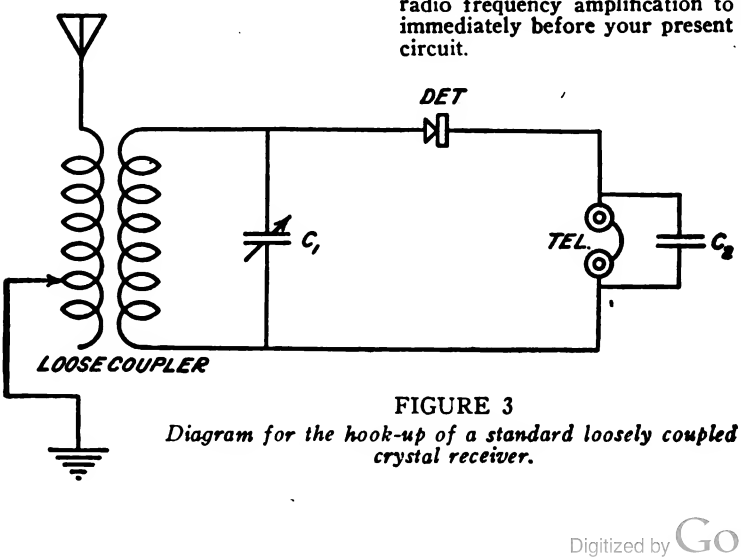


FIGURE 3
Diagram for the hook-up of a standard loosely coupled crystal receiver.

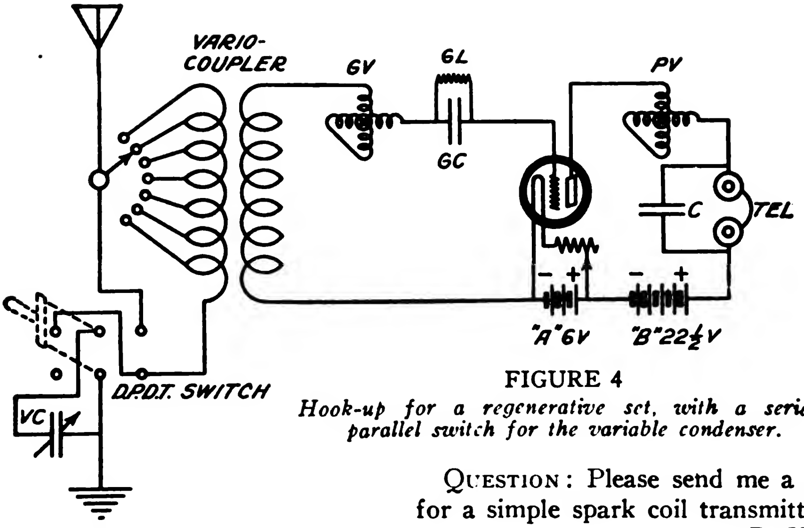


FIGURE 4
Hook-up for a regenerative set, with a series-parallel switch for the variable condenser.

QUESTION: Kindly send me a hook-up for the following: variocoupler, two variometers, variable condenser; also a circuit that shows the connections for a series-parallel switch.

J. A. BEATTY

ANSWER: The hook-up is shown in Figure 4. The variometers are designated as GV and PV, and the grid leak and condenser are marked GL and GC. C is a fixed telephone condenser. The antenna circuit is tuned by the taps on the primary and by the condenser VC. The secondary circuit is tuned by the grid variometer GV, and the plate circuit is tuned by means of the plate variometer PV. The series-parallel switch will be found very effective for changing the wavelength range.

QUESTION: Please send me a hook-up for a simple spark coil transmitter.

R. HARRIS

ANSWER: This set may be made of a Ford coil, and will operate on a few dry batteries. The wavelengths of the transmitted signals are controlled by the two clips on the oscillation transformer. See Figure 5.

* * *

QUESTION: Please give me, by diagram, the best hook-up for a plate and grid variometer, variocoupler, a series-parallel switch for a condenser in the primary of the variocoupler, and a vacuum tube detector. What "ohmage" phones would you recommend?

IVAR SWANSON

ANSWER: Consult the answer to J. A. Beatty and the diagram in Figure 4. Telephones of 3,000 ohms are recommended. This circuit should be very efficient if the instruments you intend using are of a reliable make, and if the set is assembled in a careful and workmanlike manner.

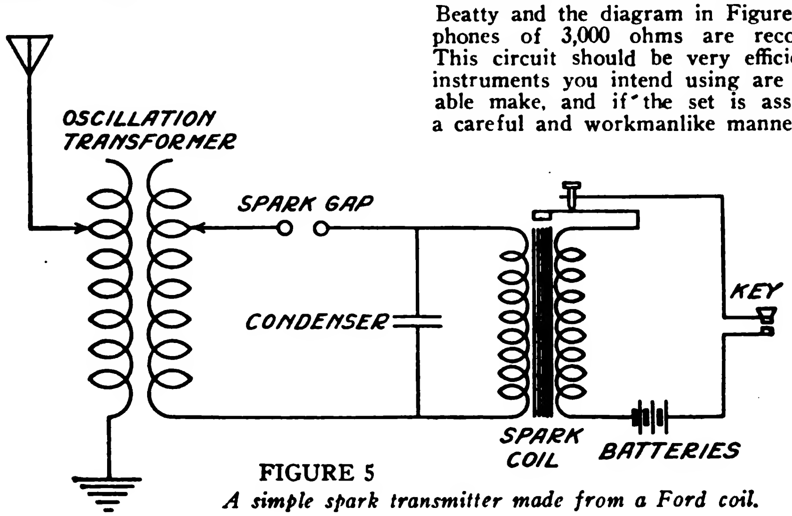


FIGURE 5
A simple spark transmitter made from a Ford coil.

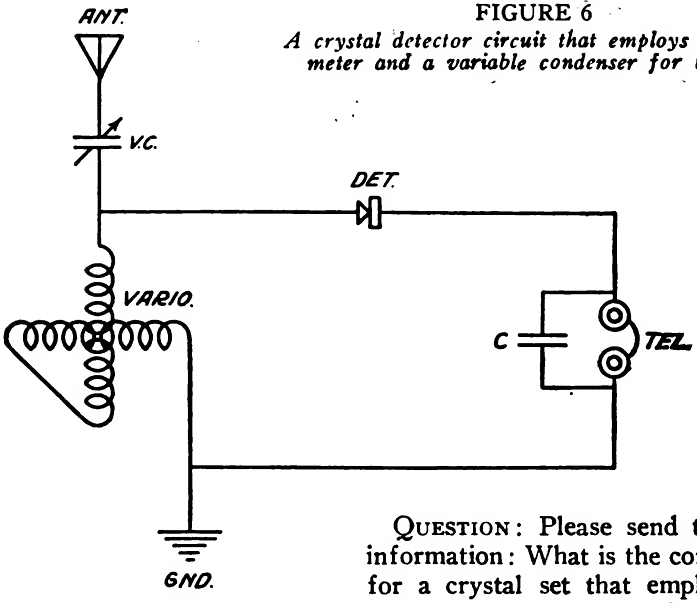


FIGURE 6
A crystal detector circuit that employs a variometer and a variable condenser for tuning.

QUESTION: Please give me a hook-up for a crystal receiving set that uses a variometer and a variable condenser.

WALTER STRANG

ANSWER: Figure 6 gives you the hook-up you require. The secondary circuit is tuned by the variometer, and the antenna circuit is tuned by the condenser and variometer in combination. A fixed condenser C is connected across the telephones. The variometer and the variable condenser both vary the wavelength of the circuit continuously, so that very minute changes in wavelength are possible and interference is reduced to a minimum.

QUESTION: Please send the following information: What is the correct hook-up for a crystal set that employs a variometer, a variocoupler, a fixed condenser, a crystal detector and phones? Would a crystal set that contains these items be helped by the addition of two coils? One coil has 16 taps, (8 turns to a tap), and the other has 11 taps, ranging from 20 turns to 5 turns to a tap.

JACK CLOVER

ANSWER: You may use the hook-up shown in Figure 7. The two coils you speak of would not help you much, but you could improve the set by the addition of a variable condenser connected across the secondary of the variocoupler. This set could be easily changed to a regenerative vacuum tube receiver.

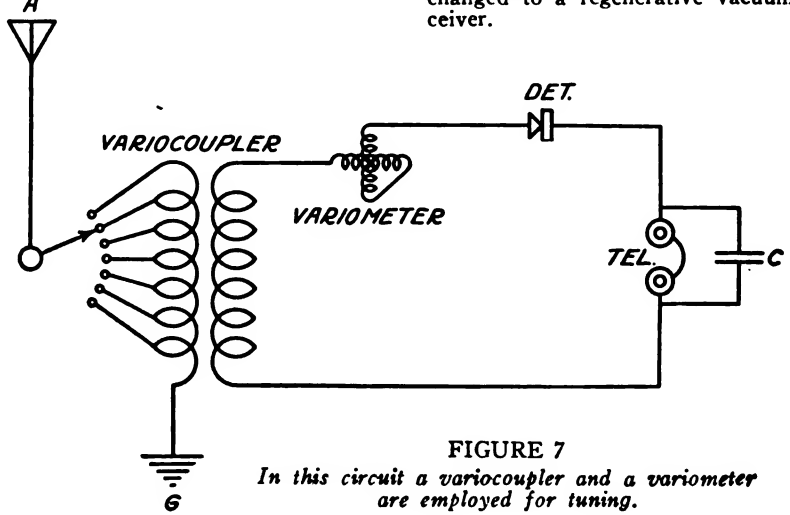


FIGURE 7
In this circuit a variocoupler and a variometer are employed for tuning.

ITEMS *of general interest that you ought to know; bits of useful information that every radio fan ought to know.*

A Radio Message Averts a Battle

JUST as the British forces were on the point of opening fire on the advancing cavalry of the Turkish Nationalists (which had just occupied Kum Kalesi in the neutral zone), and thus precipitated what in all probability would have been another war, Col. Shuttleworth, of the British forces in Chanak received a radio message from General Harington in Constantinople that gave orders to suspend the attack. Under a flag of truce the representatives of the two conflicting forces parleyed—and the impending battle was avoided.

* * *

A New Radio Set Sells an Old House

UNABLE to dispose of an old house in Dallas, Texas, an enterprising real estate operator installed the very latest radio receiving set in it, and so advertised in the leading paper. From the dozens of offers that poured in he selected one that enabled him to dispose of the property at a good price.

* * *

General Pershing Listens In

THE recent mysterious appearance of an antenna running around the top of one of the big army limousines used by General Pershing gave rise to rumors that the former chief of the A. E. F. had become a radio fan. The installation was made by the general's son, Warren, in collaboration with an obliging army sergeant.

* * *

Connecticut Amateurs Signal to Porto Rico

FOR the first time in the history of radio communication has been established between amateurs in Porto Rico and this country. Messages have been exchanged between the Porto Rico Radio Club and the American Radio Relay League headquarters in Hartford. The first message from the island to the mainland was relayed from San Juan, Porto Rico, to 4FT Atlanta, Ga., thence to 4BX at Wilmington, N. C., and finally to 1QP, J. L. Reinartz, South Manchester, Conn. A return message was transmitted from Hartford to San Juan in the record time of one hour and 27 minutes.

* * *

Radiograms by Wire

THE next time you want to send a message by radio merely drop into (or telephone to) the nearest Postal Telegraph office and enter your order. Arrangements have been completed with the Radio Corporation of America for co-operating in the handling of this traffic.

* * *

The Radio Bug Bites Royalty

Now that the Prince of Wales has joined the ranks of the radio fans and has had a set installed at Windsor Castle, high society in England may no longer hesitate to accept the new art as *de rigeur*. It is even rumored that the Prince has so interested the King and Queen in radio that receiving apparatus may be installed at Buckingham Palace.

* * *

Miniature Radio Sets for Children

THE radio station located in the Eiffel Tower is affecting the toy industry of France, according to M. Lepine, former Prefect of Paris. Little Pierre has lost interest in his tin soldiers and even in his scooter, and is now saving his centimes for a miniature radio set.

* * *

The Human Voice Spans the Atlantic

WHAT is said to be the first authentic record of the human voice being carried across the Atlantic by radio on low wavelengths was made October 6th, when Sir Thomas Lipton spoke from WOR station in Newark and was heard in London by Gordon Selfridge.

* * *

A Radiogram Saves 217 Lives

ANOTHER stirring chapter was written in the romance of radio at sea when the steamship *City of Honolulu* burst into flames while 670 miles off the California coast on October 12th.

Not only did radio keep the world informed of the progress of the fire, but brought help in time to save all of the passengers and crew. Before the days of wireless such a conflagration would have meant suffering and death.

* * *

Grand Opera in an Airplane

THE commercial passenger airplane that flies between Geneva to Paris installed a receiving set this fall and entertained its fourteen passengers with concerts broadcast from Lausaune. It is not inconceivable that members of Parliament, the French Senate and other legislative bodies will soon be enabled to attend the deliberations of their respective organizations, while they are in the air—*they* referring to the members only.

* * *

A Radio Set Squelches a Native Uprising

THE natives of Nyassaland, Central Africa, got their first introduction to radio when the British forces penetrated that territory recently with motor lorries fitted with wireless installations. So terrified were the superstitious blacks with the "machine that could speak without mouth and hear without ears" that they promptly assumed that the god of the ether could listen in even upon their secret whisperings. So they promptly behaved themselves accordingly.

International

A CORKING IDEA

When a press agent tells us that a small wire attached to corkscrew inserted in a flask acts conveniently as a new kind of radio receiver, of course we believe it—not! What the press agent really had in mind was to arouse public curiosity in the exhibits promised for a coming radio show.

* * *

Fighting Floods by Radio

To broadcast warnings of flood, not only for the purpose of summoning aid but also to warn distant residents of impending danger, a radio sending station has been installed near the source of the Verde River in Arizona—the water supply base of a 200,000-acre irrigation project. Radio offers the only means of communication between Phoenix and the upper reaches of the river, where storms often cause enormous damage to the country below.

* * *

Hypnotized through the Earphones

CAN a sane, normal human being be hypnotized by radio? Evidence in the affirmative is offered by Miss Beatrice Kyle, who donned the earphones and permitted herself to be put into a trance for a period of several hours and exhibited on a cot in a store window in Birmingham, Ala. The hypnotist was located at a radio transmitting station several blocks away.

* * *

Radio Substitutes for the School Ma'am

THE project for employing radio for educational purposes is apparently nearer fulfilment in Hawaii than in this country. The superintendent of public instruction in Honolulu has just announced plans for installing radiophones in the rural schools; eventually programs of an educational nature will be broadcast from the headquarters of public instruction. Slowly but inevitably radio is destined to bring the world's greatest educators to the Little Red Schoolhouse.

* * *

A Power Plant in a Suit Case

TESTS recently conducted at the Rocky Point Station of the Radio Corporation of America, prove that the new high-power vacuum tubes are superior to the cumbersome and expensive high-frequency alternators now in use for transoceanic radio communication. A special test set that employed six of the new General Electric Company 20 K.W. tubes, was recently put into transatlantic service, without notifying either the sending operators or the receiving operators on the other side of the world. Neither the foreign operators nor the Americans noticed any difference in the signals, so it is assumed that the signal strength was comparable with the alternator signal, although the antenna current with the tubes was only a little over half that produced by the alternators.

This is a remarkable achievement, particularly when it is borne in mind that the alternators take up almost the center floor space of the huge Rocky Point plant, whereas the tubes which accomplished the same results could almost be put in an ordinary suitcase.

WHAT *is the biggest thrill YOU ever got over the radio? Have you ever picked up a call for help? Or located a lost friend—or helped to run down a fugitive, or listened in on a conversation of peculiar personal interest to yourself? For every anecdote, humorous or grave, ranging from 50 to 300 words in length, the Editor will pay upon acceptance. Address contributions to the Editor,* ADVENTURE IN THE AIR DEPARTMENT, 9 *East 40th Street, New York City.*

I Pick Up a Warning From An Unknown Hero

TALES of the exploits of un-named heroes stir the blood and establish one's faith in the innate great-heartedness of the well-known but often maligned Human Race. Here, for example, is a true tale from the sea that comes from an experienced ship's radio operator:

We were steaming ahead through a hurricane such as is only known in the Caribbean Sea and the Gulf of Mexico. The *Grayson,* a typical tramp steamer of small tonnage, was laboring heavily in the fearful weather. Her skipper was a worried man. Shortly after dark he came into the wireless room to ask me if I had received the regular weather forecast from the radio station at Jamaica. I had not heard a thing from that station or any other for over twelve hours, and told him so. He expressed his opinion of me and of wireless operators in general.

"I've got to call at Kingston and it's a tricky harbor," he growled. "I want to know how the wind is going to set me when I make it, and it's up to you to get the reports. The last man always gave them to me and I want you to give them to me."

He slammed the door as he made his exit.

Patiently I tried to pick up some signals which would at least give me an indication that my set was working. I had been thus busying myself for over an hour when suddenly I heard "CQ, CQ," which is the signal for all stations to copy. It sounded like a ship station calling.

"CQ," he continued, "Jamaica is being shaken by terrific earthquake. Huge tidal wave sweeping Kingston harbor and vicinity."

Then followed a series of unreadable dots and dashes which dwindled into a profound silence. Not another signal, no call letters, no signature was sent.

Breathlessly I carried this missive to the skipper. He read its contents, grunted his surprise and asked, "Where did this come from?"

After I had told him I did not know where it had come from or who had sent it, he again expressed his opinion of wireless operators in general and of me in particular.

I returned to my post in the wireless cabin to listen in for more news, but a silence broken only by bursts of static had again fallen over the Caribbean.

Along toward midnight, the skipper came stamping into the cabin. He had lost some of his gruffness.

"Sparks," he said—and I knew when he addressed me as Sparks that we were on better terms—"are you sure you got this message over the wireless and didn't dream it?"

I assured him.

"Well," he mused, "there is something funny; we should have picked up the light at Kingston over an hour ago, and we can't see it yet."

"Maybe the lighthouse has toppled over," I suggested.

"Maybe," he agreed. "I'm going to haul around and steam offshore, anyway."

At eight bells, we had swung around and were putting out to sea again, and I turned in. The following morning, after breakfast, I got in touch with a British cruiser. He confirmed the dispatch I had received the previous night, and added that the radio station at Kingston had been demolished by the earthquake at noon the previous day. That eliminated the possibility of Kingston having sent that mysterious message.

Where the warning came from and who sent it is still an unsolved problem. Possibly some vessel in the vicinity, equipped

with radio, had undertaken to warn off other ships, even though caught in the tidal wave herself. Several vessels were wrecked there at the time. Perhaps some gallant operator stuck to his post in the face of death and sent the warning which saved the *Grayson* and our whole company. But the brave chap evidently never lived to tell the tale or to know of our gratitude.

E. JAY QUINBY

I Deliver a Death Message *via* the Purser

EVERY radio operator who has either received or sent a notice of death can appreciate the feelings of Mr. Hecht—both before and after the fateful message was delivered to the addressee:

While sailing on the Great Lakes as radio operator on the S.S. *Missouri* I received a message from WGO, Chicago. The message was then two days late, and it was the kind that an operator hates to either send or receive. It was worded somewhat like this:

JOHN RYAN SS. MISSOURI
YOUR FATHER IS DEAD COME HOME AT ONCE
SISTER

Instead of giving the message to a cabin boy for delivery in the usual way, I took it to the Purser and explained its contents. He said that he would deliver it in a way that would make it easier than as if Mr. Ryan received it without warning of its contents.

The Purser found Mr. Ryan in his cabin. "The operator just received a message for you; it contains some bad news from your home. Your father is dead."

Mr. Ryan dazedly repeated the Purser's words:

"My father is dead? Why, sure he's dead. He ought to be dead; he died thirty years ago!"

What the Purser said to me will have to go unprinted, and the Chicago radio station received a pointed service message.

R. H. HECHT

A Radio Message Penetrates Prison Walls

TO pick up a bit of news by radio that may save you from an otherwise sure death must give a man convicted of murder an honest-to-God thrill—particularly if that bit of news comes to him in a prison cell, literally within the shadow of the electric chair. This adventure comes from Boston:

When George Rollins, convicted of murder, was listening in on his little radio set on the evening of August 10th, he picked up a piece of information which may bring about his pardon. Rollins was in his cell, listening to the regular late news broadcast from WGI at Medford Hillside, near Boston. Suddenly announcement was made that Governor Sproul of Pennsylvania was to release Frank Smith, alias Jesse Murphy, who had confessed some months before to one of the two murders of which Rollins was convicted. The two killings occurred in February, 1917; no one had yet paid the penalty for them. Rollins and his brother Charles were both implicated and convicted; while George was awaiting sentence, Murphy confessed to one of the murders. While he did not confess to the killing, he positively stated that Rollins did not do it.

Naturally, George Rollins secured a new lease on life when he heard the news by radio that Murphy was about to be released from the Philadelphia Penitentiary and would be brought to justice in Boston.

H. M. TAYLOR

International

Broadcasting Should Benefit the Whole Community

TO THE EDITOR OF POPULAR RADIO:

"The plan you suggest seems to me an excellent one, and I hope will result in distinct benefit to the whole community."

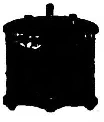
President, University of Chicago

BUILD YOUR OWN RADIO OUTFIT

HIGH QUALITY GOODS AT LOW PRICES

FAST SERVICE—THE PRICES QUOTED DELIVER THE GOODS TO YOUR DOOR

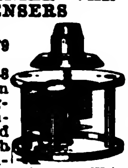
BARAWIK SPECIAL PANEL MOUNTING VARIABLE CONDENSERS



L812—43 plate .001 Mfd. $2.35
L813—21 plate .0005 Mfd. 1.90
L814—11 plate .00025 Mfd. 1.40
L815—3 plate Vernier 1.05

These are especially high grade condensers and we guarantee them to be mechanically and electrically perfect. Genuine bakelite end plates of high dielectric and great mechanical strength. Sturdy aluminum alloy plates perfectly spaced to insure smooth, even reliable capacity. Our low prices save you money. These condensers are of the very best make and are not to be compared with many inferior or cheap condensers offered. We guarantee them to please you or your money back.

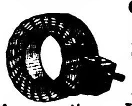
COMBINATION VERNIER VARIABLE CONDENSERS



L824—23 plate .0005 Mfd. Price $3.79
L826—43 plate .001 Mfd. Price $4.48

The latest improvement in condensers consists of regular variable condenser controlled by large knob and dial. Separate small knob mounted above dial controls a three-plate vernier condenser. This arrangement permits of very fine tuning. High-grade design and construction. Finely finished. Suitable for panel mounting.

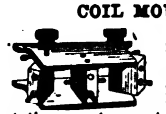
INDUCTANCE "HONEY COMB" COILS



Carefully made—fine looking coils. Highest efficiency. Low distributed capacity effect, low resistance—high self inductance. Very firm enamel impregnation. Range given is in meters when varied with .001 variable condenser. Mounted coils have standard plug mountings.

Turns	Range	Art. No.	Not Mntd.	Art. No.	Price Mntd.
25	120- 250	L301	$0.39	L320	$0.97
35	175- 450	L302	.42	L322	1.00
50	240- 720	L303	.49	L323	1.07
75	390- 910	L304	.54	L324	1.12
100	500- 1450	L305	.58	L325	1.16
150	600- 2000	L306	.63	L326	1.21
200	900- 2500	L307	.72	L327	1.30
250	1200- 3500	L308	.78	L328	1.36
300	1500- 4500	L309	.82	L329	1.40
400	2000- 5000	L310	.97	L330	1.55
500	2800- 6100	L311	1.12	L331	1.70
600	4000-10000	L312	1.27	L332	1.85
750	5000-12000	L313	1.43	L333	2.00
1000	7900-15000	L314	1.70	L334	2.38
1250	9750-19500	L315	1.92	L335	2.60
1500	14500-26500	L316	2.18	L336	2.76

COIL MOUNTINGS



L340 Three coil mounting $3.95
High grade fine looking mountings. Polished black composition. Center receptacle stationary, two outer ones adjusted by knobs. Takes any standard mounted coil.

GALENA DETECTOR

Easy fine adjustment. Crystal mounted in cup. Moulded base and Knob. Brass parts polished nickel finish. L732 Each............86c

This Guarantee Protects You
Examine the goods we ship you. They must suit you in every respect. If you are not satisfied with your purchase return the goods at once and we will refund the price you paid.

VACUUM TUBES

Standard Brands—Cunningham Radiotron. Every one guaranteed new and perfect. We will ship brand in stock unless you specify otherwise.
L105 Detector. Each....$4.45
L110 Amplifier. Each.... 5.95
L115 5 Watt Transmitter 7.70

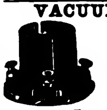
MYERS TUBES

L113 High-Mu Audion. Has 5 times amplification of ordinary tubes. Oscillates anywhere from 2 to 300 volts on plate. Each $5.00
L116 Receptacle for above. Each... 1.00
L117 Adapter to adapt Myers tubes for use in any standard socket. Each...$1.05

MYERS CHOKE COIL

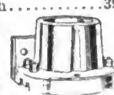
L119 Each $3.50

VACUUM TUBE SOCKETS



Our Special Socket. A wonderful value. Moulded entirely of bakelite. Four binding post connections. Right angled contact springs.
L140 Each............39c

PORCELAIN BASE AND TUBE



L144 Crosley for either panel or table mounting 42c

High Grade combination type for panel or table mounting. Metal tube. Highly insulated base.
L146 Each..............45c

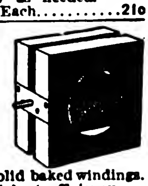
GRID CONDENSER

L162 Mounting holes spaced to fit lugs of above leak. Cap. .00025 MF..........17c
L163 Same as 162 but higher grade. Enclosed in metalcase 39c

VARIABLE GRID LEAK

Pencil mark type. Resistance may be varied exactly as needed.
L160 Each...........21c

VARIOMETER

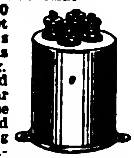


L410—Completely assembled, price $2.89.
L411—Not assembled but all parts complete, including winding form, $1.90.
Perfect in design and construction. Accurate wood forms. Correct inductive ratios. Solid baked windings. Positive contacts. Highest efficiency.

VARIO-COUPLER

With this loose coupler and two variometers, together with the necessary other parts, a highly efficient tuning set can be made. Easily mounted on panel. Primary winding on formica tube. Inductively coupled for 180 to 600 meters. Multiple taps permit fine tuning.
L415 Price, completely assembled $2.40
L416 Not assembled, but all parts complete. Price $1.35
L417 Rotor ball only. Each........29c

RADIO FREQUENCY AMPLIFYING TRANSFORMER



L995 Each.........$3.50
This transformer will get the long distance stations loud and clear. Permits of easy sharp tuning. Helps cut out static and interference. Makes your set sensitive enough to use a loop aerial. Enclosed in metal case affording perfect shielding. Suitable for panel or base mounting. Because of its special design can be mounted in any V. T. socket. Works with any make of tube. Wave ranges 150 to 550 meters. Wiring diagrams included.

OUR SPECIAL AUDIO FREQUENCY AMPLIFYING TRANSFORMERS

As high as three stages can be used without howling, due to proper impedence ratio, minimum distributed capacity, low core losses and proper insulation. Mounted style has bakelite panel with binding post connections. Unmounted has core and coils assembled with two holes in core for fastening to apparatus.
L234 10 to 1 Mounted. Each.....$3.69
L235 10 to 1 Unmounted. Each.... 2.95
L236 3 to 1 Mounted. Each...... 3.59
L237 3 to 1 Unmounted. Each.... 2.85

FILAMENT CONTROL RHEOSTATS

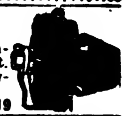
Crosley—Wound on vulcanized fiber. Adjustable to any panel. Complete with knob.
L130 Each 54c

Best grade. High heat resisting base. Diam. 2⅛ in. cap. 1½ amp. Resist. 6 ohms. 1¼ in. Knob with pointer.
L132 Each...............48c

POTENTIOMETER

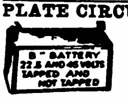
Same style as above rheostat. Gives fine "B" battery adjustment. Resistance 140 ohms.
L133 Each........................$1.65

VERNIER RHEOSTAT



Gives exceedingly fine control of a battery current. A necessity for best receiving results.
L135 Each..........$1.19

PLATE CIRCUIT "B" BATTERIES



You can make real savings on these batteries. Don't pay more. We guarantee them to equal any on the market regardless of price. Absolutely uniform. Extra long life.

L180 Signal Corps type, small size, 15 cells, 22½ volts. Each, 95c.

L182 Large Navy size, 6½x4x3, 15 cells, 22½ volts. Each...................$1.75

L184 Variable Large Navy size. 5 taps, giving range from 16½ to 22½ volts in 1½ volts steps. Each...............$1.80

L186 Double Navy size 6½x4x6, 30 cells, 45 volts. Suitable for amplifier circuits and power tube use. Two or more of these units in series may be used in C. W. and radiophone circuits. Each..$3.40

L188 Combination Tapped 45 volts, 30 cells, 6½x4x6 battery. Tapped to give 45, 22½, 21, 19½, 18, and 16½ volts. Handles both detector and amplifier tubes. Each $3.55

THE BARAWIK CO. 102 S. CANAL STREET CHICAGO, ILL.

USE BARAWIK STANDARD PARTS

YOU SAVE MONEY WHEN YOU BUY FROM US

FAST SERVICE—THE PRICES QUOTED DELIVER THE GOODS TO YOUR DOOR

SOLID BARE COPPER WIRE

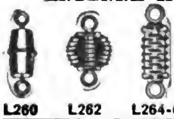
Solid bare copper wire for aerials, leads or wiring instruments.

Solid Bare Copper Wire, size 14
L240—100 ft. coil 45c
L242—500 ft. coil $2.16
Solid Bare Copper Wire, size 12
L244—100 ft. coil 61c
L245—500 ft. coil $2.75

STRANDED ANTENNA WIRE

Cabled of fine copper strands. Very flexible. High tensile strength. Best for antennas.
L248—100 ft. coil 65c
L249—500 ft. coil $2.95

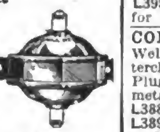
ANTENNA INSULATORS



L260 Size 1x3¼. Two for........19c
L262 Size 2⅛x3¼. Two for.......58c
L264 Size 1½x4. Two for.......80c
L266 Size 1½x L264-610½. Two for $1.35

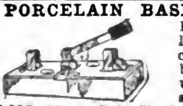
L260 L262

OUTDOOR LIGHTNING ARRESTER



L980 Price........$1.68
Protect your instruments with this lightning arrester. You cannot afford not to. Weather-proof porcelain case. Air gap type. Permanent. Durable. The most practical quality arrester obtainable. Underwriters approved.

PORCELAIN BASE SWITCHES



Fine white porcelain bases. Copper contacts and blades. Can be used as antenna switches.
L385 Single Pole Single Throw. Each 20c
L387 Single Pole Double Throw. Each 32c
L384 Double Pole Double Throw. Each 50c

SWITCH LEVERS

Moulded composition knob. Exposed metal parts polished, nickel finish. Fitted with panel bushing, spring and two set nuts. A high grade switch.
L380—1" Radius
L381—1¼" Radius } Each 22c
L382—1½" Radius

SWITCH LEVER STOP

Brass, polished nickel finish.
L386—Dozen 20c. Hundred $1.40

ONE PIECE DIAL AND KNOB

A fine looking knob and dial moulded in one piece. Neat clean cut design. Polished black finish. Clear plain engraved scale with numbers and lines in contrasting white enamel. Ribbed knob that fits the hand. The three sizes used on the same panel can be arranged to produce a very attractive effect.
Three and four inch sizes are marked 0 to 100 and 180° of the scale. 2¼ inch size is marked 0 to 9 over 270° of scale.
L900—2¼ inch Diameter for 3-16 inch shaft. Each........39c
L901—2¼ inch Diameter for ¼ inch shaft. Each........39c
L904—3 inch Diameter for 3-16 inch shaft. Each........49c
L905—3 inch Diameter for ¼ inch shaft. Each........49c
L906—4 inch Diameter for 3-16 inch shaft. Each........59c
L907—4 inch Diameter for ¼ inch shaft. Each........59c

GUARANTEED QUALITY GOODS

at money saving prices. You can build the parts purchased from us into your set and feel confident of the best results. If what you want is not shown here write us for prices—we have every part for your set ready for quick shipment and the prices are right.

RADIO JACKS AND PLUGS

Finest grade Jacks. Improved design. Best materials. Phosphor bronze springs. Silver contact points. Nickel finish. Mount on panels ⅛ to ⅜ in. thick.

Jacks Only:
L390 Open circuit. Each.......45c
L391 Closed circuit. Each.......52c
L392 Two circuit. Each.......63c
L393 Single-cir. fila. control..70c
L394 Two cir. fila. control.....88c

L395 Plug. Large space with set screws for attaching cord. Each.........54c

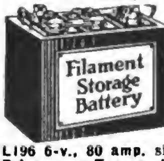
COMPETITOR JACK AND PLUG

Well made, durable, smooth working. Interchangeable with any standard Jacks and Plugs. Solder connections. Nickel finished metal parts. Fiber barrel on Plug.
L388 Two Circuit Jack. Each.......35c
L389 Standard Plug. Each.........35c

BINDING POSTS

Brass, polished nickel finish. Washer and 6-32". screw extending ⅝"... L370 Large size—barrel and knob ¾" long, dozen.........85c
L372 Smaller size—barrel and knob 9-16" long, dozen.........70c
L 370-2 L 376-8
L374 Large size with composition knob, dozen........60c
L376 Large size with hole for phone tip or wire, dozen........80c
L378 Small size with hole for phone tip or wire, dozen........38c

STORAGE BATTERY



A very high grade battery made especially for radio service. Guaranteed. Properly cared for will give years of service for filament lighting.
L194 6-v., 40 amp. size. Each..$10.00
L196 6-v., 80 amp. size. Each..$12.50
Prices are Transportation Paid

CABINETS

Fine looking cabinets solidly built. Made of genuine solid mahogany in elegant hand rubbed finish. You will be proud of your set mounted in one of these cabinets. Hinged tops. Front rabbeted to take panels. Panels not included. Prices are transportation paid.

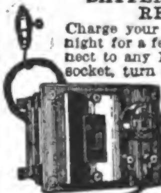
Panel Size	Inside Dimensions High	Wide	Deep	Art. No.	Price Each
6x 7"	5½"	6½"	7"	L420	$2.48
6x10½"	5½"	10"	7"	L422	2.75
6x14"	5½"	13½"	7"	L424	3.30
7x14"	6½"	13½"	7"	L423	3.60
7x18"	6½"	17½"	7"	L426	3.90
6x21"	5½"	20½"	7"	L425	3.90
9x14"	8½"	13½"	10"	L428	3.70
12x14"	11½"	13½"	10"	L430	4.40
12x21"	11½"	20½"	10"	L432	5.25

SOLID GENUINE CONDENSITE CELORON PANELS

Notice our very low prices on this fine quality grade 10 genuine solid sheet Condensite Celeron (a product with mechanical, chemical and electrical properties like formica and bakelite). Machines well without chipping. Won't warp. Waterproof. Highest mechanical and di-electric strength. Attractive natural polished Black finish which can be sanded and oiled for extra fine work.

Panel Size Inches	⅛" thick Art. No.	Price	3-16" thick Art. No.	Price	¼" thick Art. No.	Price
6x 7	L450	$0.50	L460	$0.75	L470	$0.98
6x10½	L451	.75	L461	1.18	L470	1.47
6x14	L452	1.05	L462	1.55	L472	2.05
7x14	L458	1.20	L468	2.60	L478	2.40
7x18	L453	1.55	L463	2.30	L473	3.10
7x21	L457	1.78	L467	2.65	L477	3.60
9x14	L454	1.60	L464	2.30	L474	3.10
12x14	L455	2.10	L465	3.10	L475	4.15
12x21	L456	3.15	L466	4.65	L476	6.20

BATTERY CHARGING RECTIFIER



Charge your battery at home over night for a few cents. Simply connect to any 110 volt 60 cycle light socket, turn on current and rectifier does the rest automatically. Will work for years without attention. Simple connections. Gives a tapering charge which batteries should have. You can make it pay a profit charging your friends' auto batteries. Long connecting cords with pair of battery clips. Prices are Transportation Paid.
L201 For 6 volt battery...........$13.95

BARAWIK QUALITY HEADSETS

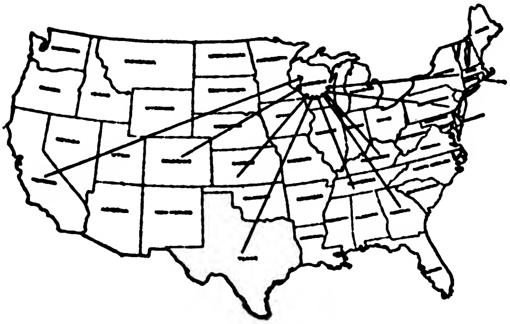
These headsets have proven on rigid tests to be one of the very best on the market. The tone quality is excellent with an unusual volume. Skilled workmen make them from only the best selected materials. The receiver cases are brass in fine polished nickel finish. Polished black ear pieces. Fabric covered head band comfortably and quickly fitted to the head. Supplied with 5-foot cord. These sets were designed to sell for much higher prices, and at our price are a wonderful bargain. We guarantee that you will be pleased with them and agree that they are the best value by far yet offered. If they don't suit you we will cheerfully return your money.
L770—2000 ohm.....$4.00

OTHER STANDARD BRAND HEADSETS

L751 Murdock 56, 2000 ohm $4.45
L752 Murdock 56, 3000 ohm 4.95
L764 Frost, 200 ohm 4.45
L766 Frost, 3000 ohm 5.40
L756 Red Head, 3000 ohm 5.85
L758 Western Electric, 2200 ohm.. 9.50
L754 Baldwin Type C with universal jack plug $16.00
L755 Baldwin Type C unit with attaching cord $7.75
L768 Brandes, 2000 ohm 7.20
L789 Holzer-Cabot, 2200 ohm 7.20

THE BARAWIK CO. 102 S. CANAL STREET CHICAGO, ILL.

Wisconsin "Listens to the world" with MR-6



FROM Wisconsin alone during one month come reports of De Forest MR-6 Receiving Sets getting California, Colorado, Kansas, Texas, Tennessee, Georgia, Kentucky, Pennsylvania, and New York—distances up to 1500 miles. One man listened across the entire continent, getting Santa Cruz, California and Atlanta, Georgia, the same evening. The unsolicited testimonials as to the way this efficient but inexpensive set "listens to the world" are on file in our office and copies will be sent to anyone interested in writing direct to the owner.

Multiply such experiences as these by the thousands of MR-6 sets in use all over the nation—to say nothing of the De Forest Everyman and Radiohome sets—and you get an idea of the way De Forest is serving the nation with the joys of radio.

De Forest manufactures receiving sets all the way from the least expensive to the most elaborate, and laboratory tested high quality parts for those who "build their own." If it's De Forest, it's built in a way worthy to sustain the reputation of that great name.

If you want the best radio has to offer—the songs, the stories, the news of the world—more clearly than you have believed possible and from farther away—you can't go wrong on De Forest!

De Forest Radio Tel. & Tel. Co.
Jersey City, N. J.

DE FOREST

Up-to-Date Radio Books

JUST OFF THE PRESS

THE RADIO EXPERIMENTER'S HANDBOOK

By M. B. SLEEPER

Gives wiring diagrams and hookups, explains the theory and operation of damped and undamped transmitting sets, and receiving equipment. The book is profusely illustrated. Tells you the things you want to know about wireless in simple, untechnical language. In this respect, it differs from most radio books in that it tells you what you want to know, and not what the author thinks you ought to know. *16 chapters. Fully illustrated.* **Price $1.00.**

Other Popular Radio Books

Radio Hook-Ups, by M. B. Sleeper. . $ .75
Indispensable to the radio amateur who designs or builds his own receiving apparatus.

Radio Design Data, by M. B. Sleeper .75
Gives tables and data for designing, receiving and transmitting apparatus.

Construction of New Types Trans-Atlantic Receiving Set, by M. B. Sleeper 75
Tells how to listen to the high-power telegraph stations of foreign countries.

Construction of Radiophone and Telegraph Receivers for Beginners, by M. B. Sleeper. 75
Tells in detail the building of radio apparatus.

How to Make Commercial Type Radio Apparatus, by M. B. Sleeper .75
Describes in detail many commercial types of transmitting spark and vacuum tube sets, both telephone and telegraph and receiving equipment of all kinds.

A B C of Vacuum Tubes Used in Radio Reception, by E. H. Lewis. . 1.00
A book explaining in detail all about vacuum tubes.

Experimental Wireless Stations, by P. E. Edelman. 3.00
A book describing all modern improvements.

Wireless Telegraphy and Telephony Simply Explained, by A. P. Morgan 1.50
A book the radio experimenter cannot afford to be without.

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TRUE TONE AT LAST!!

MUSIC MASTER HORN CONQUERS "SCREECH" AND "SNARL" AND "HOWL"

AND MAKES LISTENING A JOY!

ANY up-to-the-minute Radio Dealer will demonstrate this wonderful Horn on YOUR OWN SET. Tune in to your limit and judge the Music Master by what it delivers to your own ears.

Fits any set. No extra batteries, no extra current needed. Makes head sets obsolete. A roomful — a theatre-full! — can listen to any program and hear every cadence, every shading of music or speech, through the Music Master.

Fourteen inch aperture (Home Model) $30
Twenty-one inch (Concert, dancing, etc,) $35

Tell us your dealer's name before you request this free test. Then we can make sure he has Music Master to show you.

JOBBERS—DEALERS

Sample Music Master Horn shipped to responsible members of the Radio or Phonograph trade with FULL PRIVILEGE OF RETURN. Write for list-prices and full details.

"GERACO" LINE

Everything worth selling in Radio Apparatus of TESTED merit. Ask for price lists. See the Geraco Phonograph Attachment. Makes any Victor or Columbia a LOUD SPEAKER for Radio receiving. Use it as sound-box. Only $10.

THE GENERAL RADIO CORPORATION

Makers and Distributors of High-Grade Radio Apparatus

624-28 Market Street, Philadelphia — 806 Penn Avenue, Pittsburgh

GERACO
PROVEN RADIO PRODUCTS

Radio Rheostats of Reputation

Protecting every C-H Radio Rheostat stands a guarantee stronger than human hands can write. The decades of persistent and successful development of rheostatic control by the engineers of CUTLER-HAMMER have inspired a faith in their trade-mark that is far too worthy to forfeit.

C-H Radio Rheostats are built in two styles, Type 11601-H1 with vernier adjustment for detector tube control and Type 11601-H2 is furnished without vernier for amplifier tube control. Both rheostats have a range of four ohms with one ampere current capacity.

Type 11601-H1 with vernier... **$1.50**
Type 11601-H2 without vernier **$1.00**

Engineers the world over accept this mark as unfailing assurance of electrical and mechanical perfection—the signature of approval of the master rheostat builders. It is a protection you should demand in the purchase of your radio rheostat—a device in which precision and reliability are essential.

THE CUTLER-HAMMER MFG. CO.
Milwaukee, Wisconsin

C-H RADIO RHEOSTATS
BUILT BY RHEOSTAT BUILDERS

Like the romance of radio itself

is the story of the phenomenal growth of the company whose name has been linked with radio from the earliest days. Twelve years is a long time in radio—yet over twelve years ago—in 1909, to be exact—William B. Duck began his pioneer work in radio equipment.
Way back in those early days Mr. Duck foresaw with an almost perfect vision the ultimate growth of radio. He was the first and only one to put a "human touch" in a catalog embracing a scientific subject; he realized how largely educational such a catalog must be to accomplish its ultimate purpose—and today, with radio on every tongue, there is in Duck's "Wonder Catalog" an even larger wealth of practical radio information and diagrams than will be found in any of the earlier editions—and in language easy for the layman to understand. It is little wonder that Duck's catalog is universally known as "The Radio Amateur's Bible."

DUCK RADIO APPARATUS

At All Worth-While Radio Stores
Enquire for Duck Products at Your Dealer's

Embraces 62 instruments—58 parts—the largest and most comprehensive line produced by any radio manufacturer. They should be had at all worth-while retail stores throughout the United States and Canada. In selecting your radio equipment at your dealer's, insist on seeing Duck's products—products that have stood the test of time.

DEALERS

We offer very attractive discounts on our radio instruments. Dealers who carry "Duck" products add prestige to their radio department and create satisfied customers.

DUCK'S
Big 256-Page Combined Radio Text-Book and
CATALOG

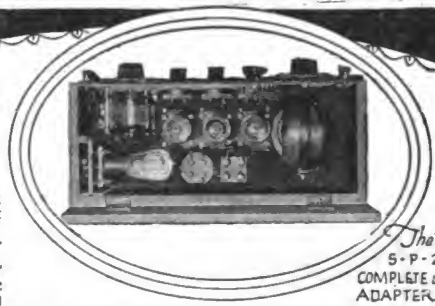
as well as all former editions is now, as in the past, all radio catalogs in one. No other other half so large. It displays not only Duck goods but the products of practically all worth-while manufacturers and contains more up-to-date and practical radio information than will be found in many text-books. Send 25c in coin for this wonderful book—a retainer that hardly pays the cost of printing.

The WILLIAM B. DUCK CO.
227-229 Superior St., Toledo, Ohio
Established 1909

TREMENDOUS DEALER ENTHUSIASM OVER REMARKABLE S-P-2 RECEIVER!

Demonstrated superiority against regenerative receivers, with list price of just $85. Popularity with public, growing in leaps and bounds,

makes it the greatest seller on market.



The S-P-2 COMPLETE *with* ADAPTER

The S-P-2 RECEIVER, now in vast production and under the severe test of hundreds of dealers everywhere, has thoroughly established its claim of ACTUAL SUPERIORITY as against any regenerative receiver now offered costing $125 to $180, based on actual comparisons. THE LIST PRICE OF THE S-P-2 IS BUT $85, WITH AN ADDITIONAL CHARGE OF $15 FOR THE ADAPTER.

The S-P-2 is a complete Receiver of radio-telephone and radio-telegraph signals over a wavelength range of from 180 to 650 meters, using three tubes, viz.: detector, one stage of radio frequency amplification and one stage of audio frequency amplification.

An Adapter representing an additional stage of audio frequency amplification, added to the S-P-2 Receiver AS SIMPLY AS INSERTING A TUBE INTO A SOCKET. Without necessitating the change of a single binding post, wire or batteries or headphones! The S-P-2 Adapter is a basic patent and is thoroughly covered.

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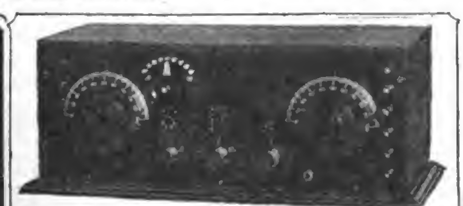
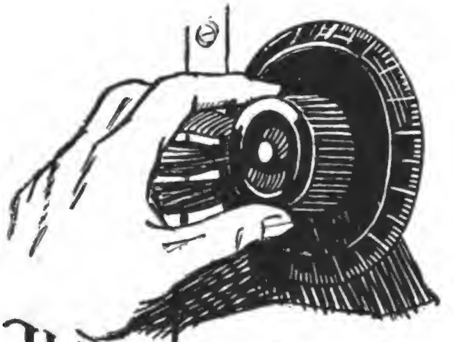
DEALERS:
Write for Catalogue 101A



PITTSBURGH RADIO SUPPLY HOUSE

963 Liberty Ave. Pittsburgh, Pa.

BELL TELEPHONE
GRANT 3632



How to stop noises when you touch dials

Have you ever noticed in tuning a radio receiving set that when you touch dials, knobs or switches it causes a humming or whistling noise? It is annoying, isn't it? These distracting sounds will disappear if you install dials, knobs and other parts made of

RADION

Tests by disinterested laboratories have shown conclusively that RADION is without exception the best material for radio parts and panels because it comes closest to being the perfect insulation.

Have you tried RADION? If not, secure a dial or other part from your dealer today. Take it home and experiment—that's the best way to become convinced of its unusual qualities.

And while at your dealer's, ask him to show you a RADION Mahoganite panel. Its beautiful mahogany grain will please you. It won't warp and is easy to work. If your dealer cannot serve you, write us direct for all information giving us his name.

Dealers Are Invited to Write for Lists

American Hard Rubber Company
11 Mercer Street New York

REAL RADIO VALUES

Order Direct and Save Money

Look Over These Holiday Specials

	Regular Price	Our Price
Unit Audion Control Panels (Detector)	$ 6.50	$ 5.00
Unit Audion Control Panels (Amplifier)	13.50	10.00
Glass-enclosed Crystal Detectors—less crystal	2.00	1.50
23-Plate Universal Condenser, bakelite ends, .0005 Mfd.	4.00	2.50
43-Plate Universal Condenser, bakelite ends, .001 Mfd.	5.00	3.00
3-Plate Universal Vernier Condenser, .000246 Mfd.	1.50	75c
Keystone Variometers, 150-580 meters	5.00	4.00
6 V, 60-80 Amp. Storage Batteries	16.00	12.00
Open Circuit Jack	.60	.33
Single Circuit Jack	.75	.40
Double Circuit Jack	.90	.48
Double Circuit Jack Filament Control	1.00	.55
Single Circuit Jack Filament Control	1.20	.63
Saturn Automatic Grip Telephone Plug	1.50	.98
Ajax Socket Rheostat	2.00	1.40
Dictograph Headsets, 3,000 ohms	.8.00	8.00
Dictograph Loudspeakers	20.00	20.00
Bestone Filament Rheostat	1.00	.60
Bestone Variocoupler, 3-inch dial, 150-600 meters	8.00	5.75
Bestone Variocoupler, 3-inch dial, 150-580 meters	7.00	4.75
Bestone Socket, metal shell, bakelite base	1.00	.75
Federal, Jr. Receiving Sets, Dictograph Headset	25.00	15.00

Everything sent F. O. B. Jersey City the same day we receive your order. Send Money by Registered Mail, Post Office or Express Money Order.

All Goods Guaranteed the Best There Is

HOLMES RADIO PRODUCTS
999-P Bergen Avenue, Jersey City, N. J.

This is station K.S.&S.Co.

Broadcasting

Better Radio Equipment

First—A Short Talk on Kellogg Head Set Superiority

Kellogg head sets are the lightest on the market which is a prime requisite for comfort in any Radio receiving. They are built of highest quality material and their design is based on 25 years engineering experience in telephone receiver construction. Kellogg head sets are supplied under the following codes and resistances: No. 69A, 2400 ohms, including head band and six foot cord; No. 69C, 2000 ohms, including head band and five foot cord; No. 74A, 1000 ohms single receiver with head band and five foot cord. Kellogg head sets are adapted for use by campers with portable receivers.

Second—A Brief Description of Kellogg Jacks and Plugs

Kellogg Radio jacks likewise are a standard product, once installed in your set, will give service and last indefinitely. Hundreds of thousands of Kellogg jacks and plugs in telephone work are in service the world over. They are designed for all standard Radio practice with the following codes: No. 501 is a four-conductor two break type, No. 502 is a two-conductor open circuit type, No 503 is a three-conductor, single break type, No. 504 is a four-conductor, single make contact type, No. 505 is a six conductor, one make, two break type.

Third—Why You Should use Kellogg Grid Leaks and Condensers

Because, first of all, they are accurate—no variation, regardless of atmospheric conditions, insuring uniform receiving.

Fourth—The Reliability of Kellogg Transmitters

Kellogg Company transmitter or microphone is proving exceptionally reliable in Radio work. Today there are over three million Kellogg telephone transmitters in service, and their record is unsurpassed.

Fifth—Kellogg Tube Sockets Are Built of Kellogg Bakelite and a Standard Product Easily Installed, and Reliable

Write us today for our Kellogg Radio bulletin, completely listing our supplies which include insulators, batteries, arresters, etc.; and investigate the latest Kellogg Radio products, every one of which is designed and built on the basis that — Use, is the Test.

Kellogg Switchboard & Supply Co., Chicago

"Signing Off" until Next Issue

"and wishing you a Merry Christmas."

For 25 Years Manufacturers of High Grade Standard Telephone Equipment

Make it the GREATER Radio Christmas

THE gift of all gifts is Magnavox Radio, the Reproducer Supreme: the gift that will mean most to every member of the family, young and old. Based upon the electro-dynamic principle, Magnavox Radio has no comparison with "loud speakers" which merely combine a megaphone with the ordinary telephone receiver.

R-2 Magnavox Radio with 18 inch horn . .	$85.00
R-3 Magnavox Radio with 14 inch horn . .	45.00
Model C Magnavox Power Amplifier 2 stage,	80.00
3 stage,	110.00

Magnavox Products can be had from good dealers everywhere. Our interesting new booklet (illustrated in three colors) will be sent on request.

The Magnavox Co., Oakland, California

New York: 370 Seventh Avenue

MAGNAVOX RADIO

The Reproducer Supreme

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, OF POPULAR RADIO

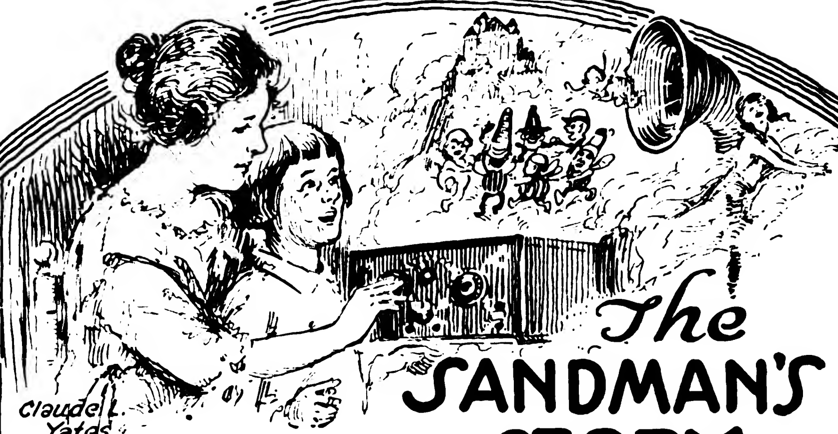
Published monthly at New York, N. Y., for October 1, 1922.

STATE OF NEW YORK }
COUNTY OF NEW YORK } ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Kendall Banning, who, having been duly sworn according to law, deposes and says that he is the Editor of Popular Radio, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, to wit: 1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Popular Radio, Inc., 9 East 40th St., New York City; Editor, Kendall Banning, 9 East 40th St., New York City; Managing Editor, None; Business Managers, Popular Radio, Inc., 9 East 40th St., New York City. 2. That the owners are: New Fiction Publishing Corporation, 9 East 40th St., New York City; Metropolitan Finance Corporation, 9 East 40th St., New York City; Medbury Blanchard, 500 Fifth Ave., New York City; Le Roy Sargent (only stockholder owning 1% or more of stock of Metropolitan Finance Corp.), 9 East 40th St., New York City. 3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None. 4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

(Signed) KENDALL BANNING, Editor.

Sworn to and subscribed before me this 18th day of September, 1922. [SEAL] EUGENE S. BIBB, *Notary Public.*



The SANDMAN'S STORY

Catalog Number Four contains Marvelous article on tuning Receiving Sets. 10 cents brings it to you

On a Tuska Radio Receiver, every evening you can hear "The Sandman's Story". This delights the children. Later comes entertaining Radio Broadcasting for grown-ups.

Tuska Radio will bring dependable broadcasting into your home, A Tuska Radio Receiver makes a wonderful Christmas Present.

Tuska Radio is substantial, reliable, dependable and recognized. Inspect today at your dealer's.

THE C. D. TUSKA COMPANY

Bartholomew Ave. Hartford, Conn.

Pacific Coast Office, 711 Mission Street, San Francisco, Calif.

TUSKA RADIO

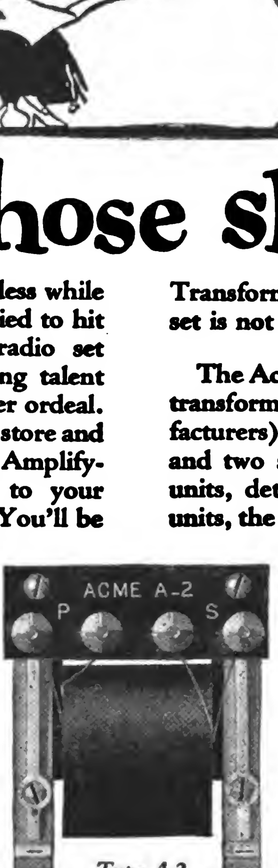
Established 1911

"Can those shrieks"

HOW often have you sat helpless while some amateur Farrar has tried to hit "High C." But when your radio set starts in to show off its shrieking talent you need not go through another ordeal. Just drop in at your nearest radio store and order an Acme *Audio* Frequency Amplifying Transformer. Hook it up to your detector set and sit back easy. You'll be surprised how clearly and distinctly incoming sounds may be heard. Then, too, the tones are natural. Something usually so lacking in the ordinary set.

You will also want the Acme *Radio* Frequency Amplifying Transformer because this will greatly increase the range of your set whether it be vacuum tube or crystal detector. Both Acme *Audio* and Acme *Radio* Frequency Amplifying Transformers sell for only five dollars. Your set is not complete without them.

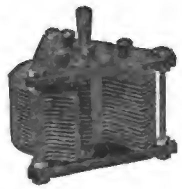
The Acme Apparatus Company (pioneer transformer and radio engineers and manufacturers) are also manufacturers of one and two stage amplifying units, detector units, detector and two stage amplifying units, the Acme Clear Speaker, the Acmefone. Acme C. W. and spark transmitting apparatus offer the amateur an opportunity to not only receive but send his own messages. For sale at radio and electrical stores or write direct to the Acme Apparatus Company, Cambridge, Mass., U. S. A., or New York Sales Office, 1270 Broadway. Ask also for instructive free booklet on the operation of amplifying transformers, both audio and radio frequency types. You need it.



Type A-2
Acme Amplifying Transformer
Price $5 (East of Rocky Mts.)

ACME

for amplification



TYPE 247 CONDENSER

DESIGNED NOT MADE

Would you buy diamonds at a corner grocery store? Of course not; you do not expect the grocer to be a diamond expert! Then why buy condensers that are simply made instead of being designed?

For many years the GENERAL RADIO COMPANY has been supplying the research and educational institution laboratories throughout the country with radio apparatus of the highest quality. The Bureau of Standards and other government laboratories are extensive users of our equipment. The experience obtained in this line has enabled us to design instruments for the citizen radio field that represent the latest developments in engineering and mechanical skill.

For seven years we have been supplying radio condensers that have been a standard for low losses and excellency in construction. Our latest addition to this line of condensers is the type 247. Send for Free Radio Bulletin 911-U and learn why these condensers are so popular.

MODERATELY PRICED AS FOLLOWS:

Type 247A— .001 M. F. Mounted, Shielded ....Price, $6.00
Type 247B— .001 M. F. Unmounted, with Counterweight.................Price, 3.75
Type 247E—.0005 M. F. Mounted, Shielded ....Price, 5.56
Type 247F—.0005 M. F. Unmounted, with counterweight ....Price, 3.25

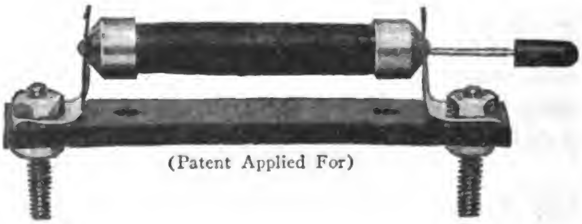
This condenser is but an example. We manufacture a complete line of the finest radio instruments and parts.

GENERAL RADIO COMPANY

Massachusetts Avenue and Windsor Street, CAMBRIDGE, 39, MASSACHUSETTS

Standardize on General Radio Company Equipment Throughout.

Do not confuse the products of the GENERAL RADIO CO. with those of the other concerns using the words "General Radio." The General Radio Co. has been manufacturing radio and scientific instruments for many years. It has no affiliations with any other company.



(Patent Applied For)

THE ONLY ONE IN AMERICA

With the usual type of "Grid Leak," which is of fixed value, it is necessary to try a number of them to determine the one best suited.

The Durham Variable High Resistance

(Adjustable Grid Leak)

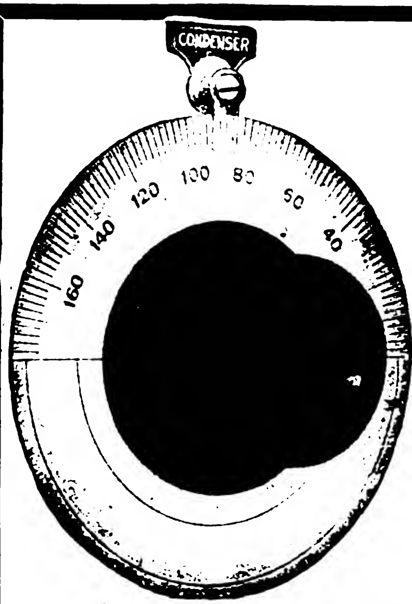
is the only one of its kind now on the market, because it is *adjustable* over a wide range and will maintain its value permanently after initial setting—It is non-inductive and has negligible capacity.

Made in two sizes: **No. 100—1,000 to 100,000 ohm range**
No. 101—100,000 to 5,000,000 ohm range

Wire or write for samples and prices to

DURHAM & COMPANY

1936 Market Street ***Radio Engineers*** **Philadelphia, Pa.**



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STANDS FOR

DISTINCTIVE APPEARANCE AND OPERATING CONVENIENCE

The THREE-IN-ONE DIAL places it beyond competition. The price is based on huge production.

FIRST Silver lacquered brass dial contrasts with Black Panel. The knob fits the fingers without fatigue.

SECOND Lower half of scale may be calibrated in meters or station call letters with pencil.

THIRD The tail of dial tag makes contact with back of dial and connects with ground, removing hand capacity.

SOMERVILLE DIAL TAGS 5c.

Completing the line of terminal and Jack tags

Makes your metal dial a shield and tells you what's what; with the celluloid pointer at 10c adds the finishing touch to your set.

ALL READINGS AVAILABLE

PRICES

4-in. Dia. Dials . . . $1.50
3¼-in. Dia. Dials. 1.00
1¾-in. Dia. Dials. .60
Specify ¼-in. or 3/16-in. Shaft Hole.

SOMERVILLE RADIO LABORATORY EST. 1917

43 CORNHILL, BOSTON

NEW CATALOG NOW READY—WRITE

THE PATHÉ LOUD SPEAKER

Has No Superior

It reproduces exactly the sound sent out and has none of the "tinny" noise that must come from a metal horn. It operates with any two stage amplifying set. Insist on hearing a Pathé operate before you buy.

Price, $24

THE SOUND WAVE CORPORATION

30 Grand Avenue, Brooklyn, New York

Makers of Quality Dials, Variometers, Variocouplers, and Loud Speakers

—And a Flock of Radio "Bugs" Step Up to Broadcast Their Christmas Orders!

Three million eager American boys know that this year Santa won't have any excuse for mistaking their orders on account of poor writing. Billie, last year got a Doll and he wrote for a Ball! Santa's **Frost-Fones** are a guarantee of clear accurate Radio reception. They will bring satisfaction to thousands of homes through their dependable service.

No. 162
2000 Ohm
Set.. $5.00

No. 163
3000 Ohm
Set.. $6.00

Something New—A Plug for 60c

No. 139
All Terminal Plug
60c

Showing screw binding post terminals with phone cord tips inserted

Frost-Radio Leaders

Frost-Radio Protector—Frost-Radio Tuning Coil
Frost-Radio Extension Cord and Plug
Frost-Radio Improved Jacks and Plugs
Frost-Radio Receiving Transformers
Frost-Fones—Cunningham Tubes
Remler Radio Apparatus

Your local dealer can supply you

Like Postage Stamps Used Everywhere
FROST RADIO
154 W. LAKE ST. CHICAGO, ILL.

HERBERT H. FROST
NATIONAL FACTORY DISTRIBUTORS
TO THE ELECTRICAL-RADIO JOBBER
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EXTEND Christmas cheer throughout the year by topping the gift list with a

FADA RECEIVER-AMPLIFIER

Every member of the household can easily operate and enjoy this master instrument, commanding, as it does, entertainment from various broadcasting stations, bringing it, in true clearness of tone, to your own fireside. Although a very simple instrument, the Fada receiver-amplifier embodies those true refinements typical of all Fada equipments and parts.

The Fada Handbook will be sent you upon receipt of 5c to cover postage. It's plumb full of things about radio you ought to know. Please mention name and address of your nearest radio or electrical dealer.

F. A. D. ANDREA
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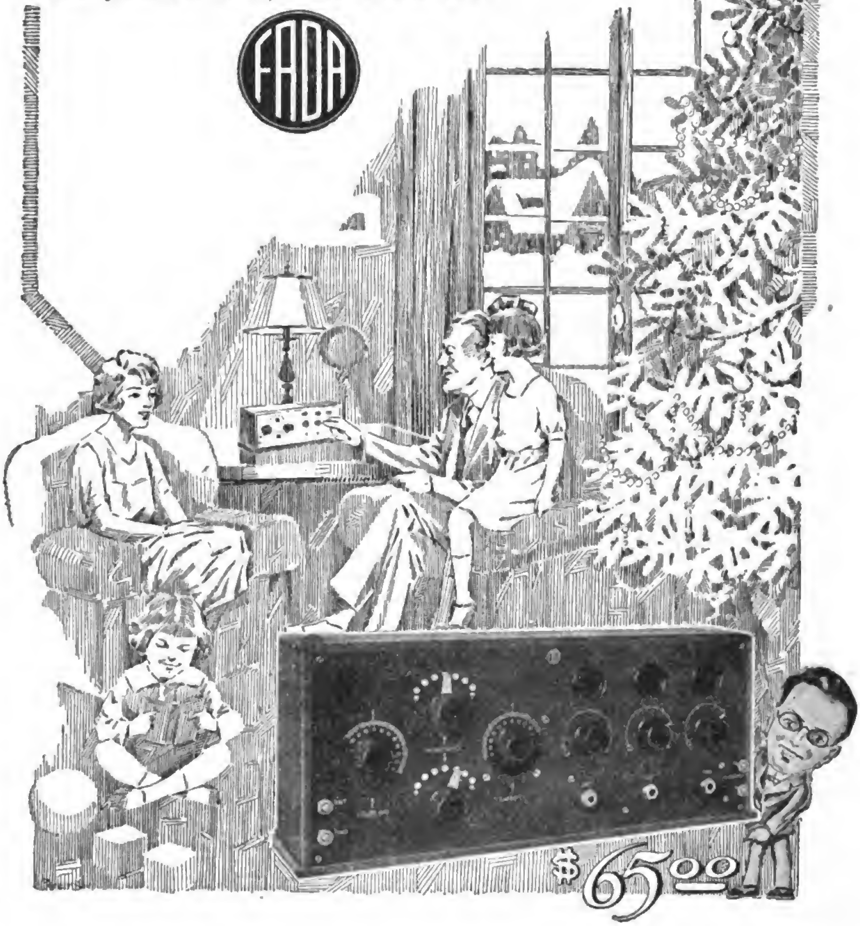
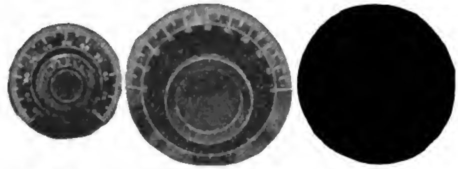


DIALS



2 in. 20c. 3 in. 27c. 2¾ in. 25c.

With Brass Insert and Set Screw

Specify whether 3-16 in. or ¼ in. Insert

$1.75 "SESCO" Variocoupler 600 Meters

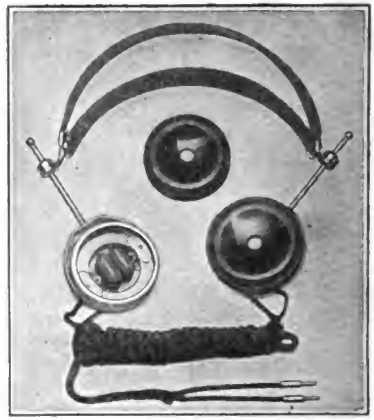
$2.50 "SESCO" Variometer

Standard Mod. 8 Phones, 2500 Ohms, $5.75

Half with order, balance C. O. D.

STANDARD ELECTRIC SALES CO.

843 Broad Street Newark, N. J.



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LIGHT WEIGHT CLEAR

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Speed Up Your Production

by sawing bakelite, formica, brass, copper, carbon, or wood on a

Junior Bench Saw

A precision machine especially adapted to the rapid and accurate production of small duplicate parts. All metal construction. Top 10" x 13", elevates for grooving, tilts 10 degrees for beveling. Saws 1½" stock. Easily driven by ¼ hp. or ⅓ hp. motor. Attachments for grinding and sanding. Special saws for bakelite, brass, etc., furnished from stock.
Junior Bench Saw with guides and one 6" wood saw **$28.75**
Motor Driven Unit as shown, mounted on iron base with ¼ hp. ball-bearing motor, belt tightener, belt, cord, plug, and switch, $60.00. Write for fully illustrated circular.
Manufacturers and amateurs will be interested in our Handilathe, Junior Bench Drill, Handisaw and Ball-Bearing Motors.
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BUILD YOUR OWN RECEIVING SET WITH

"Scientifically Superior" Radio Supplies

Receiving Combination CR-1 Complete $12.00

100 ft. coppercald aerial wire	$1.00
50 ft. insulated ground wire	.75
2 Midget aerial insulators, each 25c	.50
1 Ground Clamp	.12
1 Inductance coil (150-600 meters)	1.00
1 Crystal detector	1.50
1 Tuning condenser (General Radio)	3.25
1 Pair Murdock head phones (2,000)	5.00
4 Binding posts, each 5c	.20
1 Composition panel 6 by 9	1.00
Total	$14.32

Expert radio advice free to our customers.

SCIENTIFIC RADIO CO., 112 W. 18TH ST., NEW YORK, N. Y.

HEAR RADIO RIGHT!

Starnes Superadio Specials, same as used in the Harry T. Starnes lecture-demonstrations throughout United States and Canada, in piano finish mahogany cabinets.

Detector, and One Stage Audio Frequency Amplifier $40.00
Detector, and Two Stage Audio Frequency Amplifier $50.00
With Automatic Filament Control $60.00
Two Stage Radio Frequency Amplifier, the best $75.00
Also High Quality Three Stage Radio, and Audio Amplifiers.

WRITE FOR PRICES

Special 2500-mile Receiver, which caused so much comment on Chautauqua and Lyceum Tours recently $200.00
Also Clapp-Eastham, Westinghouse, Radio Corporation and other high-grade products, at interesting prices.

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V. T. Socket

Contact strips of laminated Phosphor bronze press firmly against contact pins, regardless of variation in length. No open current trouble possible. Socket moulded from genuine Condensite. Practically unbreakable. Special protected slot, with exterior reinforcement. Unaffected by heat or bulbs or soldering iron. All excess metal eliminated, aiding reception. May be used for 5 Watt power tube. Highest quality throughout. Price, 75c.

Special proposition to dealers and jobbers.

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The Tower of Babel will be Sending this Winter

Forty powerful broadcasting stations, all operating on one narrow wave band—that's the situation confronting the radio fan this winter. With the ordinary single circuit it will be like listening in on the Tower of Babel.

The PARAGON three circuit receiver, because of its greatly superior selectivity and sensitivity, can pick and choose between broadcasting stations of about the same signal strength with less than one per cent differential.

PARAGON three circuit receivers are always more satisfactory to operate. This winter any other kind of a receiver is obsolete and practically useless. When you pay out your good money, get a modern receiver—the PARAGON.

ADAMS-MORGAN COMPANY
20 Alvin Avenue Upper Montclair, N. J.

Also Manufacturers of
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Radio Telephone Transmitters
V. T. Control Units
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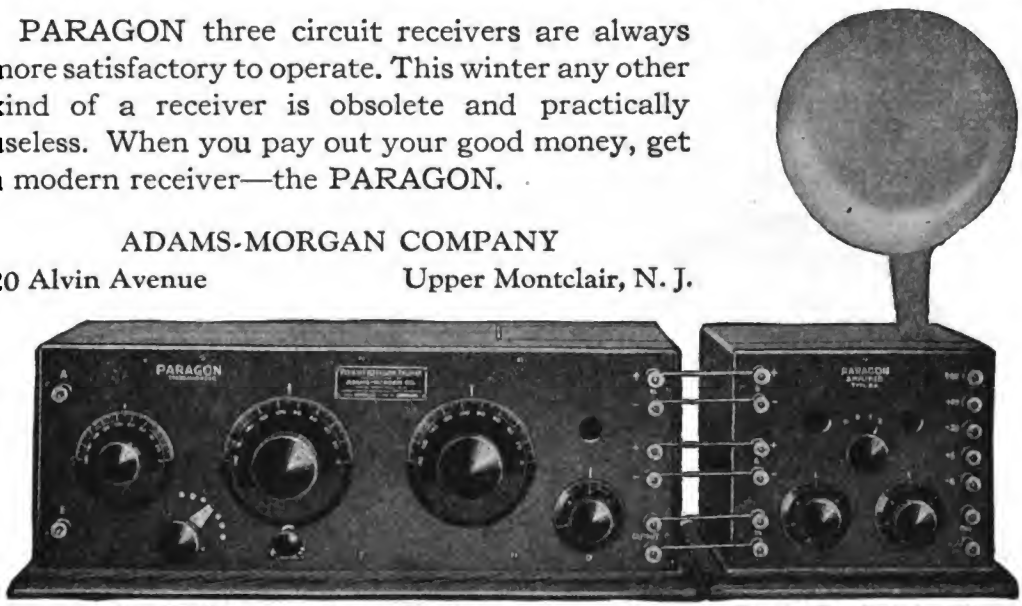
Amplifier Transformers
Detectors
Control Dials
Amplifiers
Receivers
Switches
Variometers



Type RD-5 Regenerative Receiver (including Detector) Type A-2 Two-Stage Amplifier

(Licensed Under Armstrong Patents)

PARAGON

Reg. U. S. Pat. Off.

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MICON

Tested Mica Condensers

Assure: Absolute noiselessness, Clarity of tone, Accuracy, Constant fixed capacity

Size	Price
.00025	$0.35
.0005	.35
.001	.40
.002	.40
.0025	.50
.005	.75
.01	1.50

Complete diagram of the Armstrong Super-Regenerative Circuit FREE with every purchase of MICONS.

Sizes .0025 and .005 are especially adapted for the new Armstrong Super-Regenerative Circuit. Micons can be had in all capacities from .000025 to .01.

At your dealer's—otherwise send purchase price and the desired Micons will be sent without further charge.

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RADIO & AUTO STORAGE BATTERIES CHARGED

FROM A LAMP SOCKET AT HOME At a Cost of a Few Cents With An

$15

Charges AUTO & RADIO Batteries.

F-F BOOSTER

Full Wave Automotive Magnetic Charging Rectifier for 105-125 Volt, 60 Cycle, A. C., Type A-B Charges, 6 Volt, "A" and Auto and up to 120 Volts, of "B" and Loud Speaker Storage Batteries, in Series Inductively at home overnight. Disconnecting and Multiple Connections Unnecessary. Charging Circuits Separate. No Grounds. No Danger. No Skill Required. AMMETER eliminates Guesswork. Infusible Electrodes Rectify Current. Will Charge a Dead Battery. Leave Battery Connected, Screw Plug in Lamp Socket, Snap Rectifier Clips on Battery Terminals, Turn Switch and Battery is Charged in Morning. Nothing like it made. Is it not gratifying to feel your Radio Batteries are ready for all Radiophone Music and News? Never having to be careful of, or tell friends your Batteries are Dead? Fully charged Batteries by starting car quick, require fewer expensive replacements. Do not think your Battery is Dead and Worn Out because it will not start your car. Buy a Booster which fills it with life, saves more than its cost and lasts a lifetime. 7 types built by Master of the Art and POPULARLY PRICED.

Type 6 Charges Radio "A" & Auto 6 V. Batteries at 6 Amp.	$15
Type B Charges Radio "B" Batteries up to 120 V. in Series	$15
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Type 12 Charges 12 Volt Batteries at 5 Amperes	$15
Type 166 Charges 6 Volt Batteries at 12 Amperes	$20
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Type 1626 is Combination of 166 & 1612 Charging 6 & 12 V.	$28

The Larger Types are for heavy Batteries, or where time is limited. Shipping Weights, 11 to 15 Pounds. Purchase from Your Dealer, or Send Check for Prompt Express Shipment. If via Parcel Post have remittance Include Postage & Insurance charges. Or have us ship You Type desired C. O. D. Other F-F BATTERY BOOSTERS Charge Batteries from Farm Lighting Plants and D. C. Circuits. For GROUP CHARGING use our 100-Volt Automatic ROTARY RECTIFIER, 12 Battery, 8 Ampere Size, $135. ORDER Now or WRITE Immediately For FREE BOOSTER BULLETIN 44 and ROTARY 44A.

THE FRANCE MFG. CO., OFFICES & WORKS: CLEVELAND, OHIO, U. S. A.
Canadian Rep: Battery Service & Sales Co., Hamilton, Ontario, Canada

3000 Ohm Sets $3.98

PLUS 20 CTS. POSTAGE AND PACKING
Satisfaction Guaranteed or Money Back

We mail phones the day your order arrives. Every pair tested, matched and guaranteed as sensitive as $8 to $10 Sets. Circular Free.

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Large Manufacturer of Shirts wants Agents to sell complete line of shirts direct to wearer. Exclusive patterns. Big values. No capital or experience required. Write for free samples.

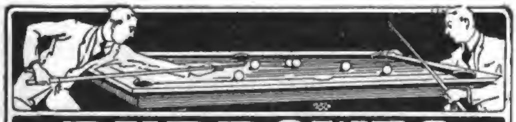
MADISON SHIRT MILLS
507 Broadway, New York, N. Y.

RADIO Complete set $15

Send for circular describing the SENSITONE Long Distance Armstrong Regenerative Radio Receiving Set, which we sell, complete with batteries, tubes, head set and aerial—all ready to listen to concerts—on easy payments. Enjoy the pleasure of radio while paying for a Sensitone.

Down $10 per Month

Harold R. Wakem & Co. 851 Washington Blvd., Chicago



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Magnificently made in all sizes, at all prices. Game exactly same as standard table. Become expert at home. Use in any room, on any house table or on its own folding stand. Quickly leveled. Put up or down in a minute. Small amount down, easy payments. Ask your dealer or WRITE TODAY for Catalog.

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35c EACH 3 FOR $1.00

NA-ALD

genuine
CONDENSITE DIAL

The dial that runs true

Numerals engraved on bevel and knob so shaped that fingers do not hide them. Thin edge with clear graduation to make accurate reading easy. Concealed set screw in metal insert. Will not warp or chip. Finish and enamel permanent.

3" dial, 35c.
2" dial for rheostat potentiometer use, 35c.
3⅞" dial, 75c.

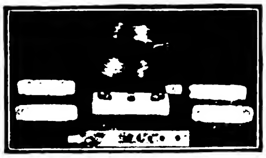
Send stamps for complete literature.

ALDEN-NAPIER CO.
52 Willow St. Dept. C Springfield, Mass.

BRILLIANTONE RADIO PRODUCTS

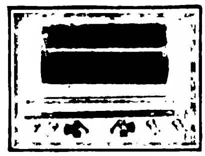
Dept. C—874 Columbus Avenue, New York

$1.00 Brings any one of these Combinations quickly to you



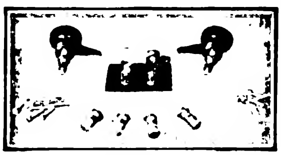
No. 1

100 Feet No. 14 hard-drawn antenna wire.
4 Porcelain insulators.
1 Solid copper approved ground clamp.
1 Single-pole, double-throw approved lightning switch.
20 Feet No. 14 weatherproof insulated lead-in wire.



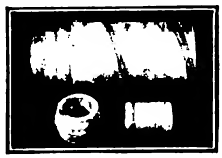
No. 2

1 Wound Enameled wire coil, 8 inches long, 3½" Diam.
2 Brass rods, 9 inches long, with evenly drilled holes.
2 Brass sliders to fit the above rods.
4 Nickel-plated brass binding posts.



No. 3

2 60-cent switches (1½-inch lever).
20 Nickel-plated brass contact points with nuts.
4 Nickel-plated brass stops with nuts.
4 Nickel-plated brass binding posts.
1 Detector stand unmounted includes: Adjustable cup, adjustable cat-whisker (any position), 2 extra binding posts, 2 connections from cup and detector to binding posts.
1 Drilled fiber base for mounting same.



No. 4

1 Nest of 4 radio tubes, 8 inches long by 3, 3½, 4, 4½ inches in diameter.

1 Spool No. 24 cotton covered wire, 375 feet.

1 Hardwood Rotor.

All the above merchandise guaranteed or money refunded.

CUT HERE

PLEASE CHECK BEFORE ITEMS DESIRED—FILL IN COUPON AND MAIL

A FEW OF OUR SPECIALS

B. R. P. PRODUCTS

☐ B.R.P. Rheostats, fibre base (Tapered Type) .... $ .50
☐ B.R.P. Rheostats, porcelain base .... .75
☐ B.R.P. Potentiometer (200 ohms) 1.00
☐ B.R.P. Moulded Sockets (unbreakable) 1.00
☐ B.R.P. Audio Frequency Transformers (11 to 1) 4.00
☐ B.R.P. Radio Frequency Transformers (150 to 500 M.) 3.00
☐ B.P.R. Variometer (to 800 meters) 3.00
☐ B.R.P. Variocouplers (Panel and Laboratory Type in one) 3.50

B. R. P. Variable Condensers Guaranteed Capacity Tested by the Rubican Laboratories, Phila., Pa.

TYPE "A"—MOULDED ENDS

☐ 3 Plate, capacity .00005 .... $1.50
☐ 7 Plate, capacity .0001 .... 2.00
☐ 11 Plate, capacity .0003 .... 2.50
☐ 23 Plate, capacity .0005 .... 3.00
☐ 43 Plate, capacity .001 .... 3.50

TYPE "B"—ALUMINUM ENDS

☐ 3 Plate, capacity .00005 .... $1.00
☐ 7 Plate, capacity .0001 .... 1.25
☐ 11 Plate, capacity .0003 .... 1.50
☐ 23 Plate, capacity .0005 .... 1.75
☐ 43 Plate, capacity .001 .... 2.25

BRILLIANTONE RADIO PRODUCTS

Dept. C, 874 Columbus Avenue, New York

STANDARD MERCHANDISE AT REDUCED PRICES

☐ $4.50 Thordarson Amp. Transformers (Audio) $3.00
☐ $7.00 UV712 Audio Frequency Transformers (Radio Corp.) 6.00
☐ $6.50 UV1714 Radio Frequency Transformers (Radio Corp.) 5.50
☐ ZETA Radio Frequency Transformer 3.50
☐ Brandes "Superior" (2200 ohms) 6.75
☐ Murdock (3000 ohms) 5.00
☐ Federal (2200 ohms) 6.50
☐ Klosner Vernier Rheostat 1.00
☐ Bradleystat (Best Vernier) 1.65
☐ Jacks, single, open or closed (Firth) .... .35
☐ Jacks, double, closed (Firth) .... .50
☐ Plugs, bulldog grip (Firth) 1.00
☐ .002 and .005 Mica-Bakelite Condensers .... .25
☐ .0005 and .00025 Condensers with Var. Leak .25
☐ .0005 and .001 Fixed Mica-Bakelite Condensers .... .20
☐ Two-Slider Tuning Coil (mounted) 1.50

BRILLIANTONE RADIO PRODUCTS
Dept. C, 874 Columbus Avenue, New York
Enclosed find money order for articles ordered. I agree to pay parcel post charges when delivered.

Name ....
Address ....
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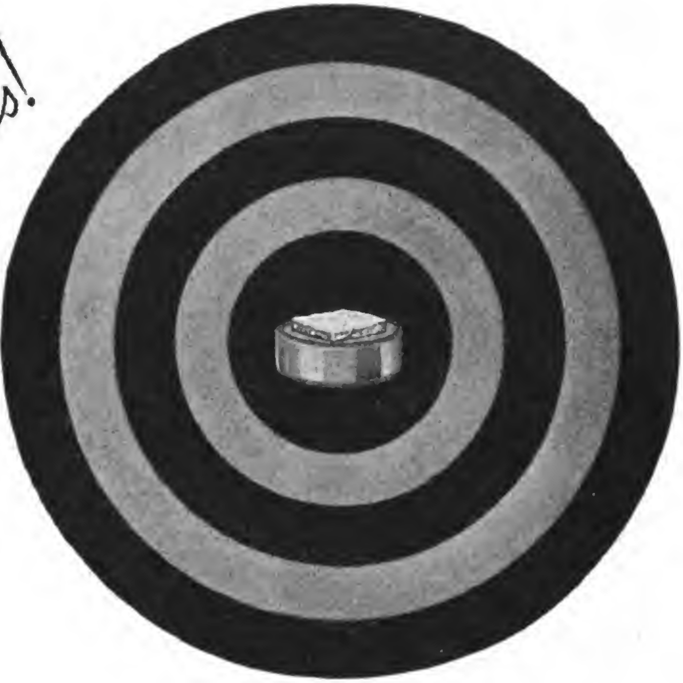
Nuggets of Sensitiveness!



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Good results depend upon your hitting the super-sensitive spot of a sensitive crystal. There's only one way to be sure of good results, and that's to be sure you're using the right crystals.

It's mighty annoying to waste time (and entertainment!) because of worthless crystals.

Hit the bull's eye the first time and every time. Play safe, take no chances—use the original, proven crystals —the "NAA" Arlington Tested brand. Each "NAA" is selected from *sensitive bulk stock*, and is *individually tested* and guaranteed super-sensitive.

"NAA" Galena, Silicon or Goldite: Price per crystal, individually packed—$.25.

Mounted crystals, set in Wood's metal in brass cup, $.40. At your dealer's, or direct postpaid.

The Newman-Stern Co

The Newman-Stern Bldg., Cleveland, O.

Also producers of the famous "Red-Head" Radio Receivers and the Teagle line of *Better* Radio Equipment.

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Please send POPULAR RADIO for one year to:

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And also to this other new subscriber. Here is a two-dollar bill—(or a check for two dollars).

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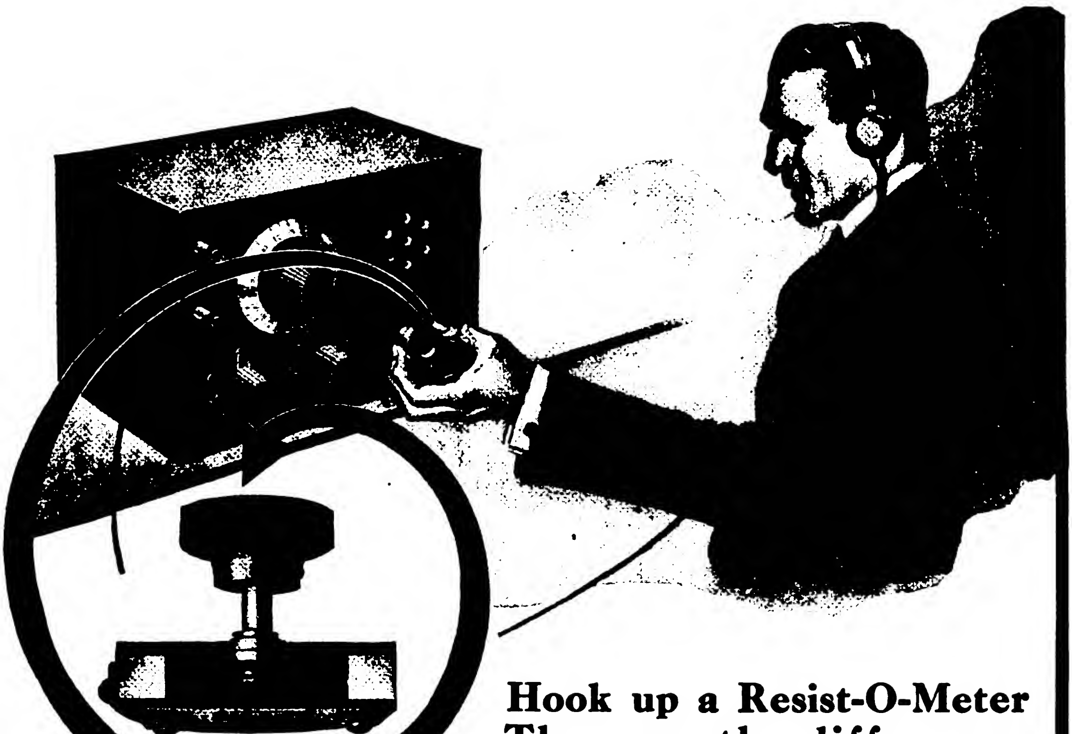

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Wear the Brooks Appliance, the modern scientific invention which gives rupture sufferers immediate relief. It has no obnoxious springs or pads. Automatic Air Cushions bind and draw together the broken parts. No salves or plasters. Durable. Cheap. Sent on trial to prove its worth. Never on sale in stores as every Appliance is made to order, the proper size and shape of Air Cushion depending on the nature of each case. Beware of imitations. Look for trade-mark bearing portrait and signature of C. E. Brooks which appears on every Appliance. None other genuine. Full information and booklet sent free in plain, sealed envelope.

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Variable Condenser

Most advanced design, with highest quality material and workmanship thruout.

Duraluminum end plates; pig tail connection. Accurate plate alignment, convenient binding posts and genuine Condensite Na-ald Dial. Bent or shorted plates unknown in this condenser.

Prices range from \$2.50 for 3 plate Vernier with dial to \$4.70 for 43 plate Precision.

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RUSH your name and address and we will tell you HOW you can get this RADIO SET ABSOLUTELY FREE. RADIO SET comes to you complete, with single slide tuning coil, crystal detector and phone condenser, AND DOUBLE HEAD PHONES. No batteries required; no experience. Write Today for Free Radio Plan.

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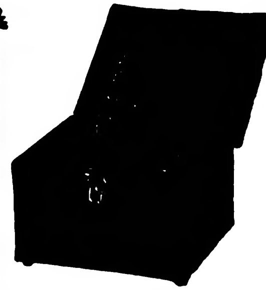
Increase the Range of your AERIOLA SR. with the new AC AMPLIFIER



AERIOLA AMPLIFIER
Model AC
Complete with 2WD-11A vacuum tubes (without batteries)

$68.00

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This symbol of quality is your protection

THE new A C Amplifier, to a considerable extent, increases the reception possibilities of the Aeriola Sr. With head telephones and the A C Amplifier reception ranges of one hundred to three hundred miles become possible for the owner of an Aeriola Sr., depending on local conditions. Used with the Vocarola loud-speaker, the Aeriola Sr. and A C Amplifier fill a whole room with music and speech received over distances of ten to thirty miles.

Anybody can make the simple connections required, including mother and the girls.

See this New Amplifier at Your Dealer's

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Clear radio reception *is* a matter of *batteries.* Elimination of most *noises* is a matter of batteries, rather than static or other interference.

Irregular voltage output, natural in ordinary "B" batteries, causes noises. Unvarying current output stops these noises—and this marvelously clear and life-like reception results.

Because RADIOBATS "A" and "B" are the only batteries *able* to act *correctly,* we urge you to listen to a demonstration at your dealer's.

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RADIOBATS "B"—as well as "A"—are *leak-proof because they have the only solid electrolyte;* and are more economical, because, like "A" Batteries, they are indefinitely *rechargeable at home.*

Send your dealer's name and address that we may arrange an immediate demonstration.

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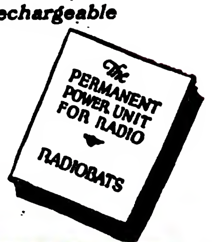

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Equip your set with "A" and "B"

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